Lower Duwamish Waterway Group

Port of Seattle / City of Seattle / King County / The Boeing Company

RECOVERY CATEGORY RECOMMENDATIONS REPORT

FINAL

Prepared for:

U.S. Environmental Protection Agency
Region 10

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ACRONYMS AND ABBREVIATIONS

AOC	Administrative Order on Consent
BEHP	bis(2-ethylhexyl)phthalate
COC	contaminant of concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
dw	dry weight
EAA	early action area
ENR	enhanced natural recovery
FS	Feasibility Study
LDW	Lower Duwamish Waterway
LDWG	Lower Duwamish Waterway Group
PCB	polychlorinated biphenyl
RAL	remedial action level
RI/FS	Remedial Investigation and Feasibility Study
RM	river mile
ROD	Record of Decision
SCO	sediment cleanup objective
STM	sediment transport model
USGS	U.S. Geological Survey

1 INTRODUCTION

This report presents recommendations for adjusting the recovery category assignments presented in the Lower Duwamish Waterway (LDW) Record of Decision (ROD; USEPA 2014). The recommendations are based on information obtained from the waterway user survey and assessment of in-water structures (Integral and Windward 2018) conducted by the Lower Duwamish Waterway Group (LDWG) in accordance with the third amendment of the Administrative Order on Consent (AOC; USEPA 2016). The recommendations consider relevant chemistry data made available after April 2010 (the cutoff date for inclusion in the LDW Feasibility Study (FS; AECOM 2012) that have been compiled under the third amendment to the AOC and the Pre-Design Studies Work Plan (Windward and Integral 2017). The LDW FS (AECOM 2012) defined recovery categories to facilitate the assignment of remedial technologies to specific areas of the site; these categories were incorporated into the LDW ROD (USEPA 2014).

The FS and ROD recovery category designations are based on the potential for sediment contaminant concentrations to be reduced through natural recovery or for subsurface contamination to be exposed as a result of physical processes (i.e., erosion and scour). The defined recovery categories are mapped in Figure 12 of the ROD, and the specific criteria upon which they were developed are presented in Table 23 of the LDW ROD (USEPA 2014), titled "Criteria for Assigning Recovery Categories" (replicated as Table 1 of this document). Based on these categories and other considerations, the ROD specifies how remedial technologies are to be assigned to specific areas. In general, capping and dredging are assigned to areas with less potential for natural recovery and a higher likelihood of scour or other disturbance. Enhanced natural recovery (ENR) and monitored natural recovery are assigned to areas where disturbance is less likely and recovery is predicted to occur. Remedial action levels (RALs)[1] and their application differ by recovery category designation (Table 28 from the ROD, titled "Remedial Action Levels, ENR Upper Limits, and Areas and Depths of Application"; replicated as Table 2 of this document).

For this report, the recovery categories map from the ROD (Figure 12; USEPA 2014) has been updated with information collected during the waterway users survey and in-water structures assessment (Windward and Integral 2018) and with post-FS chemical trend data. In addition, recent Green River sediment loading data were evaluated relative to sediment transport model (STM) results (Appendix A) to assess whether uncertainties in upstream sediment loading would require reexamining the previous STM conclusions.

[1] RALs were developed for the four human health risk driver contaminants of concern (COCs; total PCBs, arsenic, cPAHs, and dioxins/furans) and the 39 benthic COCs.

The resulting preliminary adjustments to recovery categories are presented in Section 3 of this report. Final adjustments to recovery categories, if needed, will be determined during remedial design. These adjustments will consider additional information collected during remedial design, such as evidence of scour revealed by up-to-date bathymetric data, changes in mudline elevations, contaminant trend data, and changing waterway uses.

2 RECOVERY CATEGORY DELINEATION CRITERIA

2.1 FS RECOVERY CATEGORY DELINEATION METHODS

Recovery categories were delineated in the FS through the mapping of physical criteria and contaminant trend findings (Table 1). Physical criteria included the following:

- Identification of vessel scour areas based on a visual review of a sun-illuminated grid produced from a 2003 comprehensive site-wide bathymetric survey conducted for the Remedial Investigation and Feasibility Study (RI/FS)
- Identification of berthing areas through review of the 2002 U.S. Army Corps of Engineers Port Series report (USACE 2002)
- Use of the STM to estimate net scour/deposition areas and 100-year high-flow scour depths.

In the FS, results of the physical criteria evaluation were then reviewed in light of empirical contaminant trends data to potentially override recovery category assignments on a case-by-case basis.

The contaminant trends assessment followed a three-step process. First, sample locations with the appropriate data were identified as: 1) surface sediment[2] grab locations resampled within 10 ft of one another, or 2) core samples with two sample intervals in the top 2 ft[3]. Second, concentration changes for total polychlorinated biphenyls (PCBs) and for the other contaminants of concern (COCs; evaluated as a group) were calculated, and each location was mapped in one of four color categories:

- Red: contaminant concentration increased more than 50 percent over previous or deeper concentration
- Gray: change in concentration was less than 50 percent or concentration changes were mixed (for other COCs as a group)
- Blue: contaminant concentration decreased more than 50 percent from previous or deeper concentration

[2] Samples used to evaluate direct contact in intertidal areas (0 to 45 cm) were not used in this evaluation.
[3] In a particular core, a sample from the 0- to 1-ft interval was compared to a sample from the 1- to 2-ft interval to indicate a temporal trend.

- Green: neither sample in a pair or top of core was detected above the benthic sediment cleanup objective (SCO) or RAL for carcinogenic polycyclic aromatic hydrocarbons (cPAHs).[4]

Third, the results for each resampled location or core were grouped into a summary designation for each location/area, as defined in Appendix D of the FS. These data were generally interpreted in the FS as empirical overrides to the physical criteria, based on best professional judgment, as follows.

- Areas with all red/increasing symbols could be adjusted to Category 1.
- Areas with mixed results by COC or concentration changes less than 50 percent could be adjusted to Category 2.
- Areas with more than 50 percent decreases or a mix of decreasing and changing by less than 50 percent could be adjusted to Category 3.
- Areas with data below the benthic SCO (green) are also suitable for Category 3 because these areas have historically recovered to the benthic SCO or were not historically impacted above the benthic SCO.[5] Category 3 is described as "Predicted to Recover," which means that there is at least one line of evidence that natural recovery is occurring, but can also include areas where both the older and newer data are below the benthic SCO.

2.2 METHODS USED TO REFINE RECOVERY CATEGORIES IN THE PRE-DESIGN STUDIES

This section presents the methods and data used to determine if changes are recommended to the recovery category delineations documented in the FS and ROD based on new information collected since the FS. The FS/ROD criteria for delineating recovery categories (Table 1) were followed, and where new information was available, recovery category adjustments are recommended, as appropriate (Figures 1a–f).

New information was available for three of the four physical lines of evidence listed in Table 1 (berthing areas, STM-predicted 100-year high-flow scour, and STM-derived net sedimentation). The fourth line of evidence, vessel scour observations, was not reconsidered in the pre-design studies because new bathymetric data have not been collected. Bathymetry will be reassessed as part of remedial design.

[4] Dioxins/furans were not evaluated in the FS, due to low data density.
[5] The RAL is used for cPAHs because there is no benthic SCO for cPAHs.

Berthing area information was compiled through interviews of waterway users (Integral and Windward 2018). STM-related evidence was assessed based on an Anchor QEA review of the STM in light of new upstream sediment loading information (Appendix A). This new information was assessed relative to the potential to affect predicted net sedimentation and predicted high-flow scour. Findings for the physical lines of evidence are discussed in Sections 3.1 and 3.2 and in Appendix A. Chemical lines of evidence were evaluated using FS and post-FS data; the findings are discussed in Section 3.3

2.2.1 Berthing Area Information

To collect additional information about berthing areas and vessel traffic, 62 properties adjacent to the LDW were identified as having potential waterway-dependent activities (Integral and Windward 2018). Representatives for these properties were invited to participate in a voluntary interview. Sixteen individuals (representing 39 properties) participated in an in-person interview with the survey team. Thirteen individuals (representing 12 properties) provided information to the survey team through a phone call. Information about the 11 remaining properties could not be obtained during the survey effort. Given the high response rate (51 of 62 properties), the waterway users survey addresses most data gaps related to berthing areas from the FS (Integral and Windward 2018). The remedial design and remedial action efforts will need up-to-date information about berthing areas and will include continued coordination with adjacent property owners to address any updates to water-dependent uses.

The waterway user survey focused on the collection of information about current and potential future waterway uses and activities with the potential to disturb the sediment bed to a degree that could alter the projected recovery potential (and recovery category designations) identified in the ROD. Examples of such activities include maneuvering and anchoring of ships and barges, spud use, dragging of bridle chains, and future berth and wharf development and maintenance projects. Detailed results are presented in the Waterway User Survey and Assessment of In-Water Structures report (Integral and Windward 2018).

2.2.2 STM Assessment

Two outputs from the STM were used in the FS as physical lines of evidence for recovery category designations: depth of scour during a 100-year high-flow event and mapping of net sedimentation or net scour areas. Anchor QEA evaluated the original STM outputs from the FS report (AECOM 2012), as well as a revised calibration conducted in 2008, to determine how a U.S. Geological Survey (USGS) suspended sediment transport study on the Green-Duwamish River conducted after the FS (February 2013 to January 2017) could have potentially changed the STM outputs. The original STM upstream sediment loading inputs used a 21-year simulation from 1960 to 1980. This evaluation was conducted to determine if the original conclusions related to LDW sediment transport processes would be changed based on new loading data (Appendix A). Section 3.2 summarizes the conclusions of this effort.

2.2.3 Contaminant Trends Assessment

2.2.3.1 Resampled Surface Sediment

Contaminant trends were evaluated following the methods used in the FS. Post-FS surface sediment data collected by individual parties were identified in the pre-design studies. In addition, surface sediment data were collected by LDWG as part of the pre-design studies. Where these stations were within 10 ft of an RI/FS surface sediment station's location, concentration changes over time[6] were evaluated. The evaluation excluded locations within early action areas (EAAs), including the ENR area adjacent to the Duwamish/Diagonal EAA. In the FS and ROD, recovery category designations were not assigned in the EAAs. A total of 111 RI/FS locations have been reoccupied during sampling conducted since the FS as summarized below:

Resampled Surface Sediment Locations

	Number of Locations	Sampling Dates
Post-FS LDW sediment data	97	2010–2017
Pre-design studies LDW sediment data	14[a]	2018
Total	111	

[a] Eighteen RI/FS locations were identified for reoccupation as part of the pre-design studies. Four locations were reoccupied at a distance greater than 10 ft from the original location and thus were not included in this evaluation.

Percent concentration changes from an older to a newer sample at a resampled location were calculated for total PCBs, cPAHs, arsenic, and bis(2-ethylhexyl)phthalate (BEHP) (Tables 3a–d, respectively, as well as Tables 4a–d for the Duwamish/Diagonal EAA perimeter stations[7]).

[6] The time elapsed between sampling events varied among the locations. Where a location has been sampled multiple times, such as part of long-term monitoring around the Duwamish/Diagonal EAA perimeter, the newest sample result was compared to the oldest sample result in order to capture the longest time trend. Evaluation of the longest time period available is expected to provide the best estimate of long-term recovery potential, based on current waterway conditions.

[7] The Duwamish/Diagonal EAA has seven perimeter stations that were sampled from 2003 to 2012. Dredging and capping activities occurred in 2003–2004, and an ENR layer was placed in 2005 on an area adjacent to a portion of the constructed areas. Because the perimeter locations represent a long time series, reflecting pre-EAA to post-construction conditions, the data were tabulated separately (Tables 4a–d). The percentage difference between 2003 (pre-remediation) and 2012 was used for trend calculation and mapping purposes. An eighth resampled location near the Duwamish/Diagonal EAA (Figure 3) was sampled in 1998 (location DR010) and in 2018 (LDW18-SS-170). The data for this location are in Tables 3a–d because it is not part of the long-term monitoring for the EAA.

Total PCBs, cPAHs, and arsenic were selected because they are human health risk drivers.[8] BEHP was selected because it had the second highest number of benthic SCO exceedances in the RI/FS data set (following total PCBs). The same color categories discussed in Section 2.1 were used to classify the results.[9] Reoccupied locations with both samples below the benthic SCO (or cPAH RAL) are mapped as "green". The data tables also provide the percent change in concentration for these locations and identify the percent change with a red, gray, or blue font color, even if the trend code for recovery category mapping (and mapped color) is green. The results of this evaluation are discussed in Section 3.3.

Analysis of resampled surface sediment locations introduced an element of uncertainty for at least two reasons. First, locations could be up to 10 ft apart. Because LDW surface sediments have spatial heterogeneity, with steep chemical gradients and isolated hot spots, moving several feet off-station could yield different results, even during the same sampling event. Spatial heterogeneity can mask actual recovery (or concentration increases) occurring in the LDW. In addition, not all samples were collected by LDWG; LDWG relied on the data reports prepared by others to provide accurate positional information. Only data with sufficiently documented and appropriate quality control measures were used in this analysis.

Second, among methods that are recognized as appropriate, analytical variances of up to 25% in the concentration results are not uncommon and are accepted by data validation processes. These variances can occur between two analyses of the same sample using the same method. This analytical uncertainty was taken into consideration by defining an increase or decrease as a change of >50% relative to the original concentration.

These uncertainties support the consideration of resampled locations within general areas of the LDW vs. over-reliance on evaluations of individual points. Therefore, the evaluation of chemical trends (Section 3.3) is organized by area.

2.2.3.2 Cores

Four cores with two sample intervals in the top 2 ft have been collected since the RI/FS. These four cores were all collected from the river mile (RM) 1.4–1.5W embayment, and they were analyzed only for PCBs in the 1–2 ft interval. Therefore, total PCBs were the only COC evaluated in these cores (Table 5). Percent changes for total PCB concentrations were calculated by depth in the cores (the concentration in the 0–1 ft interval was compared to the concentration in the 1–2 ft interval to determine the color category for the core).

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[8] Dioxins/furans were not evaluated because insufficient data were available.

[9] For cPAHs, the threshold for green was the site-wide RAL of 1,000 µg TEQ/kg dw.

3 PRELIMINARY RECOVERY CATEGORY RECOMMENDATIONS

This section presents the results of the recovery category assessment conducted for the pre-design studies based on the physical and contaminant criteria discussed in Section 2. The physical and chemical results are discussed separately in this section and then combined for a unified recommendation in Section 4.

3.1 BERTHING AREAS

Information obtained from waterway user interviews (Integral and Windward 2018) resulted in the identification of five berthing areas that were not previously identified in the FS (Figures 1a−f and 2). The waterway user interview and structures survey report documents these findings (Integral and Windward 2018).

Based on the criteria in Table 1, the presence of a berthing area qualifies an area for recovery Category 2. Evidence of scour is required to qualify a berthing area for Category 1. Vessel scour was not reexamined in this exercise because new bathymetry data would be needed to do this. Therefore, in this evaluation, new berthing areas were considered Category 2. Identification of vessel scour, through bathymetric surveys during design, could result in some of these areas being changed to Category 1.

In this evaluation, the identification of berthing areas in areas mapped as Category 3 in the FS, changed five of the six following areas to Category 2 (Figure 2). In addition, one new berthing area was identified, for a total of 7 acres (Figures 1a–f and 2; Table 6):

- Shoreward of the Duwamish/Diagonal EAA (RM 0.5E; Terminal 108) where Salmon Bay (tug services) is conducting berthing activities.
- At RM 0.55 to 0.85 along the eastern side of Kellogg Island where General Construction/Kiewit and Manson Construction (marine construction companies) are conducting berthing activities. Derrick barges are moored here with spuds, and other barges are rafted to the derrick barges. These companies moor vessels at this location.
- On the southern end of Kellogg Island at RM 0.95 is a lay berth used by Alaska Marine Lines. Barges are moored to pilings.
- South of Slip 2 at RM 1.8 where Filter Engineering's overwater structures are being used for berthing by Sampson Tug and Barge.

- At RM 2.35W near the former MC Halvorsen Marina where marina floats have been removed, and the remaining overwater structure is used to berth Boyer Towing barges.
- At the Waste Management berth on the north side of the mouth of Slip 4. The property is used as a transload facility, and based on the interviews, the berthing activity is more frequent than determined during the FS.

Two berthing areas were identified as non-operational during the interviews with Ash Grove Cement and General Recycling/Nucor Steel (RM 0.0E and RM 0.4W, respectively; Figure 1a) and during the in-water structures assessment; however, they were assigned to Category 1 in the FS due to vessel scour and STM-predicted scour (as documented in FS Appendix D; AECOM 2012), so no recovery category change is recommended. Vessel scour and STM-predicted scour that led to Category 1 classification in the FS did not change, regardless of whether the areas are actively in use for berthing.

Just downstream of the former MC Halvorsen Marina, near the RM 2.2 inlet, Boyer Towing uses two piles to berth barges. This area represents a newly mapped berthing area identified during the waterway user interviews (in addition to the list above). However, this area had already been designated as Category 2 in the FS (as documented in FS Appendix D; AECOM 2012), so no change to the recovery category designation is recommended. Vessel scour and STM-predicted scour were not identified in this area during the FS. Because the area was already in Category 2 in the FS, the identification of this area for berthing did not change the recovery category classification.

Based on the interviews, a berth at RM 2.9W was reduced in size following the removal of a permanently moored barge that had been used as part of the in-water structure (RM 2.9W; Figure 1d). The barge had been removed from this area, and an interviewee indicated that a barge will not be used in this manner (as moorage structure) in the future. Therefore, the size of the berthing area has been reduced; this change is shown on Figure 1d. However, the entire former berthing area was designated as Category 1 in the FS due to vessel scour, so no change to the recovery category designation for this area is recommended.

3.2 STM CRITERIA

Two outputs from the STM were used as physical lines of evidence for recovery category designations: depth of scour during a 100-year high-flow event and net sedimentation/scour areas. Anchor QEA evaluated the sensitivity of the STM output to reduced upstream sediment loads from the Green River system to determine if the STM results would have been affected. The analysis concluded that the newer USGS sediment transport data would not significantly change the net sedimentation or net scour area predictions or the high-flow scour depths presented in the FS (Appendix A). Therefore, no changes to the recovery categories are recommended, based on the STM lines of evidence.

3.3 CONTAMINANT TRENDS DATA

This section discusses trends in contaminant concentrations by comparing the results of co-located samples collected during and after the RI/FS. The discussion is organized by area, from downstream to upstream[10]. All concentration changes for total PCBs, cPAHs, arsenic, and BEHP are presented in Tables 3a−d and 4a–d. Figure 3 displays the trend code for recovery category mapping (green, blue, gray, or red) resulting from a comparison of the oldest sample to the newest sample at a location, as well as the trend code for the new core data. Tables 3a–d and 4a–d provide two sets of trend colors for locations below the benthic SCO or cPAH RAL: 1) the trend code column assigns green when concentrations are below these thresholds and thus no active remediation is required, similar to Figure 3, and 2) the percent change column uses red, gray, or blue font color regardless of a trend code designation of green. In these cases, the percent change can be more representative of noise around ambient concentrations in the LDW or analytical variability than expected recovery trends.

The discussion below describes the chemistry lines of evidence and concludes with a recommended recovery category designation for each area. In many cases, both the older and the newer sample result for a particular COC were below the benthic SCO or the cPAH sitewide RAL; the COC at that location is, therefore, below the threshold for evaluation (green).

- RM 0.1W—One surface sediment location was resampled in this area. The area was identified as Category 2 in the FS due to increasing total PCB concentrations within a core collected during the RI/FS (LDW-SC05, per FS Tables D-1 and D-2; AECOM 2012). Mercury also exceeded the SCO in the top interval of this core. No cores with two sample intervals in the top 2 ft have been collected in this area since the FS. The concentrations of the contaminants in the resampled surface sediment location were low (green). Because the RI/FS core revealed a PCB increase and cores have not been resampled in this area, no recovery category change is recommended.
- Duwamish/Diagonal EAA perimeter (RM 0.4–0.6E)—Near this EAA, perimeter monitoring data are available annually from 2003 to 2012, and, overall, the data demonstrate steady or decreasing concentrations along the perimeter of the EAA. Because the contaminant concentrations are generally either low, steady, or showing

[10] These areas were selected solely for purposes of discussion in this report, based on data for a defined geographic area, such as a slip, or for a cluster of closely spaced samples. The bullets do not represent specific areas where remedial action decisions will be made.

improvement, with the occasional fluctuations in concentrations[11] from year to year (Tables 4a–d), the area around the Duwamish/Diagonal EAA remains designated as Category 3, and no recovery category change is recommended.

- RM 0.6 to 0.8 near Kellogg Island—Three locations in this area north of Kellogg Island were resampled and analyzed only for PCBs. Total PCB concentrations are a mix of improving and steady. The area was defined as Category 3 in the FS, and no recovery category change is recommended.
- Slip 1—In 2015, numerous surface sediment samples were collected as part of a Slip 1 characterization (Integral 2015; Tables 3a–d). Concentrations are generally improving (blue) and steady (gray), with many sample concentrations below the threshold for evaluation (green). The data are consistent with the existing recovery category assignments (Categories 2 and 3), and therefore no changes are recommended. Although some of the trends in the slip are improving, this area is heavily used for berthing of derrick and flat barges (in-water construction equipment); therefore, the designation of Category 2 on the south side of the slip is appropriate, and no recovery category changes are recommended.
- Outside of Slip 1—The 2015 Slip 1 surface sediment sampling event also included locations outside of the slip (Integral 2015). The FS recovery category designation is Category 1, due to vessel scour, in the bench and Category 2 in the navigation channel. The contaminant trends are generally improving (blue) and steady (gray), with some low sample concentrations (green). However due to the scour and vessel traffic in this area, no recovery category change is recommended.
- RM 1.1E—In 2011, a sample was collected at RM 1.1E by King County as part of a combined sewer overflow characterization event (King County 2012) (Tables 3a-d). All four contaminants evaluated are below the thresholds for evaluation (green), consistent with the FS recovery category designation of Category 3, and no recovery category change is recommended.
- RM 1.4–1.5W embayment—This embayment, which is located behind a large overwater structure, is shallow with restricted vessel traffic and was designated as Category 3 in the FS. The total PCB concentrations are decreasing or steady in the two resampled surface locations and in two of the four cores. However, in the other two cores, total PCB concentrations are higher in the 0–1 ft interval than in the 1–2 ft interval (red). The other three COCs assessed were analyzed in only one of the two resampled surface sediment locations. Their concentrations are below the thresholds for evaluation (green) or decreasing (blue). Because the contaminant trends data are mixed, the available

[11] The increase in PCB concentration in 2012 at DUD_9C (the only red category) is not consistent with the other sampling dates for this location or the other sampling locations along the Duwamish/Diagonal perimeter for which the overall contaminant trends are decreasing or steady (Tables 4a–d).

trends in the cores are only for PCBs, and the physical conditions limit vessel traffic, no recovery category change is recommended. Additional chemistry data collection during remedial design may better inform the recovery category designation in this area currently slated for dredging.

- RM 1.6—The single resampled surface sediment location in this area has low concentrations (green) of all four contaminants. This area was designated as Category 3 in the FS. Thus, no recovery category change is recommended.
- RM 1.9—Two of the four resampled locations near RM 1.9 have concentrations below the threshold for evaluation (green) for all four contaminants considered. The other two locations have steady (gray) and improving (blue) trends, as well as concentrations below the threshold for evaluation (green). The three locations on the west side of the LDW are in a Category 3 area, and near the edge of a Category 2 area (due to berthing). The area on the east side of the LDW is in a newly designated Category 2 area because of the berthing area identified during the waterway user interviews. Therefore, no recovery category changes are recommended.
- RM 2.2W inlet—A subset of contaminants was analyzed in six resampled locations within this inlet. Arsenic concentrations are below the threshold for evaluation (green), and total PCB concentration changes are mixed in this area with high and variable PCB concentrations (the highest total PCB concentration in surface sediment in the RI/FS data set [2,900,000 µg/kg] was collected in this area in 2007). The area was designated as Category 2 in the FS because of mixed chemistry trends (Table D-2 in FS; AECOM 2012). No recovery category change is recommended.
- RM 2.8, Slip 4—Since the FS, most of Slip 4 has been remediated through two separate early actions. Construction activities were completed in 2012 at the head of Slip 4. Closer to the mouth, construction activities were completed in 2015 as part of the Boeing Plant 2 EAA, which included dredging and backfilling along the south side of the mouth of Slip 4. The only area in the slip that has not been remediated is the northern side of the mouth of the slip, which is designated as Category 3. Multiple samples have been collected and analyzed for PCBs in this area, and one sample was analyzed for all four contaminants. The resampled sediment trends in the slip are either below the threshold for evaluation (green) or increasing (red). Because of the recent actions in adjacent EAAs, and because samples were often collected the same year or just after remedial action, the contaminant data are difficult to interpret with regard to natural recovery potential. No recovery category change is recommended based on chemistry. However, the recovery category designation is recommended to change to Category 2 in this area based on the physical criteria (berthing) discussed in Section 3.1.
- RM 3.0W—One location has been resampled in this area since the RI/FS data set. PCBs were undetected in the 2005 FS sample location. Six new samples were collected at this location during Boeing Plant 2 perimeter monitoring from 2010 to 2015. Their total PCB

concentrations ranged from 63 to 166 µg/kg dw. Although these total PCB concentrations are higher than that in the 2005 sample, four of the six concentrations are below the threshold for evaluation (green; Table 3a). Arsenic concentrations are also below the threshold for evaluation (green). This area was designated as Category 3 in the FS, and no recovery category change is recommended.

- RM 3.5 and 3.7W—In-water remediation associated with the Terminal 117 EAA was completed in 2015 on the western shoreline of the LDW. Perimeter stations at the Terminal 117 EAA were sampled before and after the EAA construction activities. The data are either below the thresholds for evaluation (green) or are improving (blue). This area was designated as Category 3 in the FS, and no recovery category change is recommended.
- RM 3.7E—In-water work associated with Jorgensen Forge was conducted on the eastern shoreline in 2014. Two locations were sampled in 1997 just upstream of the Jorgensen Forge EAA and resampled in 2012 and 2018. Total PCBs concentration changes were increasing (red) at the 2012 location and were steady (gray) at the 2018 location. This area was designated as Category 2 in the FS, and no recovery category change is recommended.
- RM 3.8–3.9W—COC concentrations in the resampled surface sediment locations in this area were below the threshold for evaluation (green). This area was designated as Category 3 in the FS, and no recovery category change is recommended.
- RM 4.1E—One resampled location on the edge of a Category 1 area had concentrations below the threshold for evaluation (green) for all four contaminants. This area was designated as a Category 1 area in the FS due to vessel scour. No recovery category change is recommended.
- RM 4.2, Slip 6—Only arsenic was analyzed in the resampled location in Slip 6, and the concentrations were below the threshold for evaluation (green). This area was designated as Category 3 in the FS, and no recovery category change is recommended.
- RM 4.5—One reoccupied location at RM 4.5W was analyzed for PCBs. The total PCB concentration was below the threshold for evaluation (green). This area was designated as Category 3 in the FS, and no recovery category change is recommended.
- RM 4.9—Recovery category designations were not made upstream of RM 4.75 because it is outside of the STM domain.[12] However, data are available for four resampled locations around RM 4.9. The contaminant concentrations are either below the threshold for evaluation (green) or decreasing (blue) in this area.

[12] In addition, the upstream end of the 2003 sitewide bathymetric survey was at RM 4.8, where a bridge prevents the upstream transit of survey vessels.

Overall, no recovery category changes are recommended based on the current assessment of chemistry trends alone. Additional information collected during remedial design will confirm if any recovery categories need to be modified.

4 PRELIMINARY RECOMMENDATIONS

Information obtained from waterway user interviews (Integral and Windward 2018) resulted in the identification of five berthing areas that were previously not designated as such in the FS (Figures 1a–f and 2). They are located: (1) on the eastern and (2) southern sides of Kellogg Island (RM 0.6–0.9 and RM 0.95, respectively), (3) inshore of the Duwamish/Diagonal EAA (RM 0.5E), (4) upstream of Slip 2 (RM 1.9E), and (5) just upstream of the RM 2.2W inlet. It is recommended that these five berthing areas, totaling 5 acres, be changed from Recovery Category 3 to 2.

In addition, it is recommended that a 2-acre berthing area at the mouth of Slip 4 that was previously mapped in the FS and was assigned to Recovery Category 3 be changed to Category 2 because the frequency of berthing has increased since the FS. The berth was in Category 3 in the FS due to other lines of evidence (FS Table D-1; AECOM 2012).

In total, it is recommended that recovery category changes from Recovery Category 3 to 2 occur in six areas for a total of 7 acres based on the addition of berthing areas. No recovery category changes based solely on contaminant trends or STM lines of evidence are recommended at this time. Figure 2 shows the recovery categories and the areas recommended to change from Category 3 to 2.

No other category changes are recommended at this time. Additional changes will be considered during remedial design when new bathymetry will allow assessment of scour to be reevaluated as a line of evidence in the recovery category designation, and where chemistry data collected for design purposes could provide another line of evidence for recovery. Chemistry trends can also provide information about areas expected to recover from above to below RALs or vice versa. They can also provide information about ongoing, localized sources and depositing sediment.

5 NEXT STEPS

Recommendations for any further recovery category changes will be developed during remedial design, and the recommendations from this report will be reevaluated at that time. Bathymetric surveys conducted during design will evaluate the vessel scour line of evidence, which is considered in Category 1 designations. In some instances, the waterway user survey identified berthing areas in Recovery Category 1 that are no longer used for vessel berthing. Scour evaluations conducted during design can be used to determine whether cessation of berthing activities has reduced or eliminated scour potential in these areas or if the areas remain susceptible to scour due to transiting vessels or other physical disturbances. Recovery categories and technology assignments will be finalized within the LDW based on design-level data.

The available contaminant data, as summarized for this report, are largely available from sampling performed by individual parties in the LDW such that some areas contain many resampled locations and others have no data for this analysis. The report made use of existing, relevant data; no new data were collected specifically to support the evaluation. An area-specific sampling and analysis program will be developed during remedial design to characterize the limits of RAL exceedances and to delineate the boundaries of active and passive remedial technology boundaries. These additional data will also provide information on recovery potential where it has a bearing on technology assignments. In some locations, remaining uncertainty in recovery category designations may not affect the outcome, because the technology assignment may be driven to dredging or capping regardless of recovery category.

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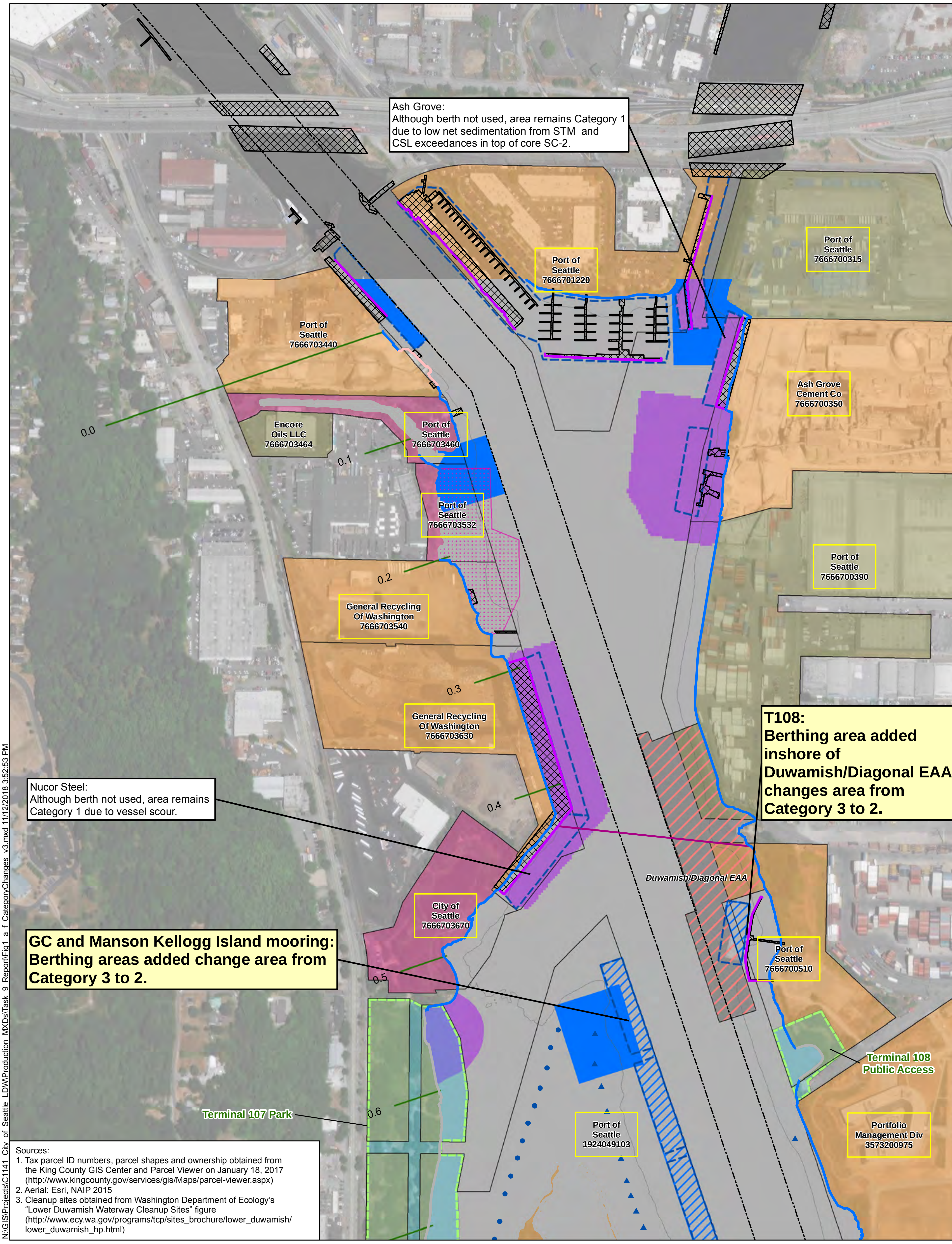
FIGURES



Sources:
1. Tax parcel ID numbers, parcel shapes and ownership obtained from the King County GIS Center and Parcel Viewer on January 18, 2017 (http://www.kingcounty.gov/services/gis/Maps/parcel-viewer.aspx)
2. Aerial: Esri, NAIP 2015
3. Cleanup sites obtained from Washington Department of Ecology's "Lower Duwamish Waterway Cleanup Sites" figure (http://www.ecy.wa.gov/programs/tcp/sites_brochure/lower_duwamish/lower_duwamish_hp.html)

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Recovery Category
- Category 1: Recovery Presumed to be Limited (77 acres)
- Category 2: Recovery Less Certain (44 acres)
- Category 3: Predicted to Recover (229 acres)

Area Changed from Category 3 to 2 (7 acres)
Text

Property Use
- Waterway-Dependent Users
- Recreational Use Businesses/Associations
- Residential and Waterfront Properties without Water-Dependent Facilities
- Tribal Users
- Washington Department of Ecology Cleanup Site
- Early Action Area

- Overwater Structure
- Underwater Utility
- Navigation Channel
- River Mile Marker
- Pile
- Dolphin
- Pile Group
- Berthing Area
- Public Property/Park

Shoreline Structure
- Armored Slope
- Vertical Bulkhead
- Exposed Bank
- Dock Face

0 200 400
Feet
N

Notes:
1. Only tax parcel ID numbers are shown at locations where a property is owned by a private party/trust.
2. Annotations are provided only where mapping of recovery categories and/or berthing areas has changed.
3. EAA = Early Action Area
4. Parcel IDs and names outline in yellow indicate a response to the survey.

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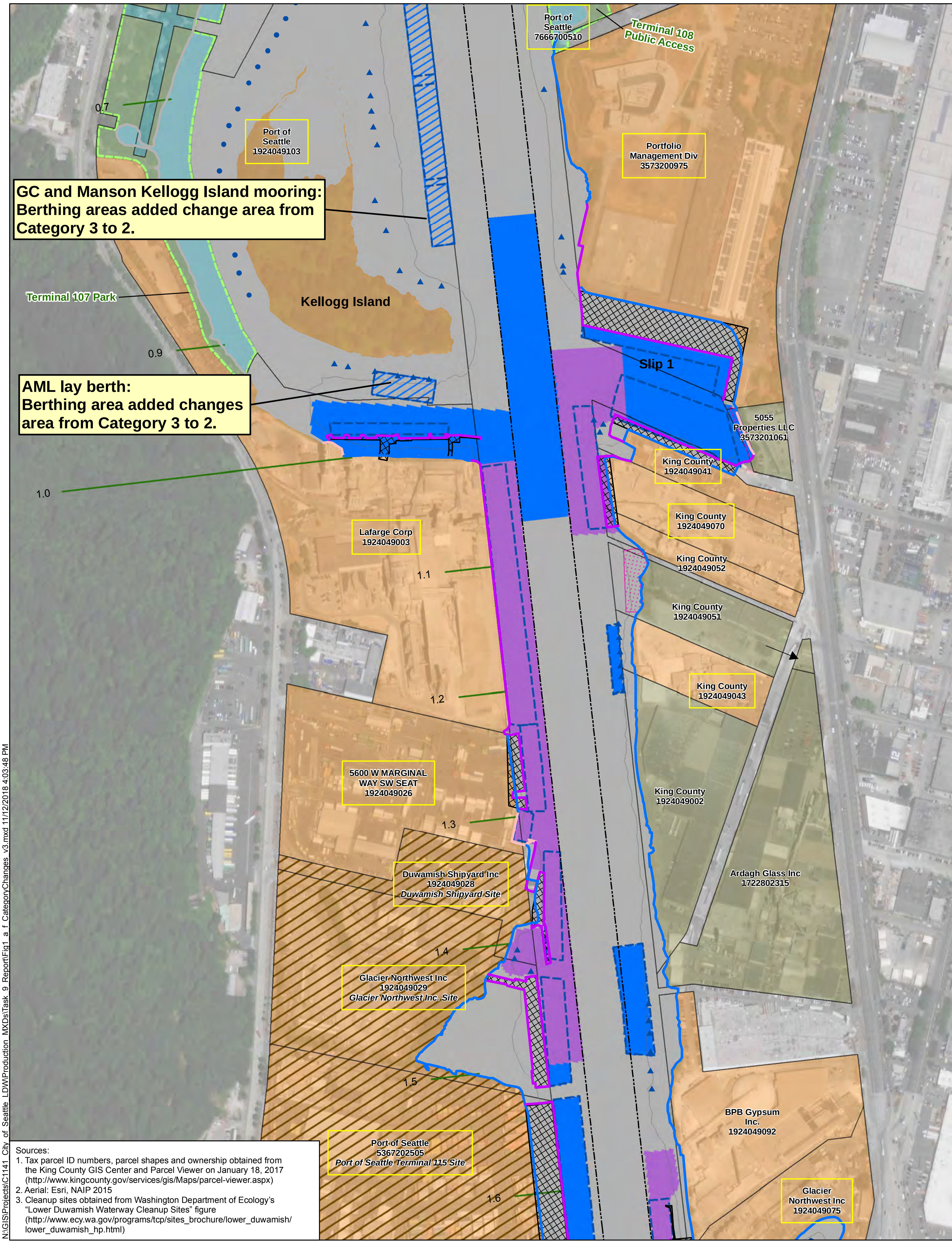
Figure 1a.
Overview of Recommended Recovery Category Changes



Sources:
1. Tax parcel ID numbers, parcel shapes and ownership obtained from the King County GIS Center and Parcel Viewer on January 18, 2017 (http://www.kingcounty.gov/services/gis/Maps/parcel-viewer.aspx)
2. Aerial: Esri, NAIP 2015
3. Cleanup sites obtained from Washington Department of Ecology's "Lower Duwamish Waterway Cleanup Sites" figure (http://www.ecy.wa.gov/programs/tcp/sites_brochure/lower_duwamish/lower_duwamish_hp.html)

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Recovery Category
- Category 1: Recovery Presumed to be Limited (77 acres)
- Category 2: Recovery Less Certain (44 acres)
- Category 3: Predicted to Recover (229 acres)

Area Changed from Category 3 to 2 (7 acres)
- Text

Property Use
- Waterway-Dependent Users
- Recreational Use Businesses/Associations
- Residential and Waterfront Properties without Water-Dependent Facilities
- Tribal Users
- Washington Department of Ecology Cleanup Site
- Early Action Area

- Overwater Structure
- Underwater Utility
- Navigation Channel
- River Mile Marker
- Pile
- Dolphin
- Pile Group
- Berthing Area
- Public Property/Park

Shoreline Structure
- Armored Slope
- Vertical Bulkhead
- Exposed Bank
- Dock Face

0 200 400
Feet

N

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2. Annotations are provided only where mapping of recovery categories and/or berthing areas has changed.
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4. Parcel IDs and names outline in yellow indicate a response to the survey.

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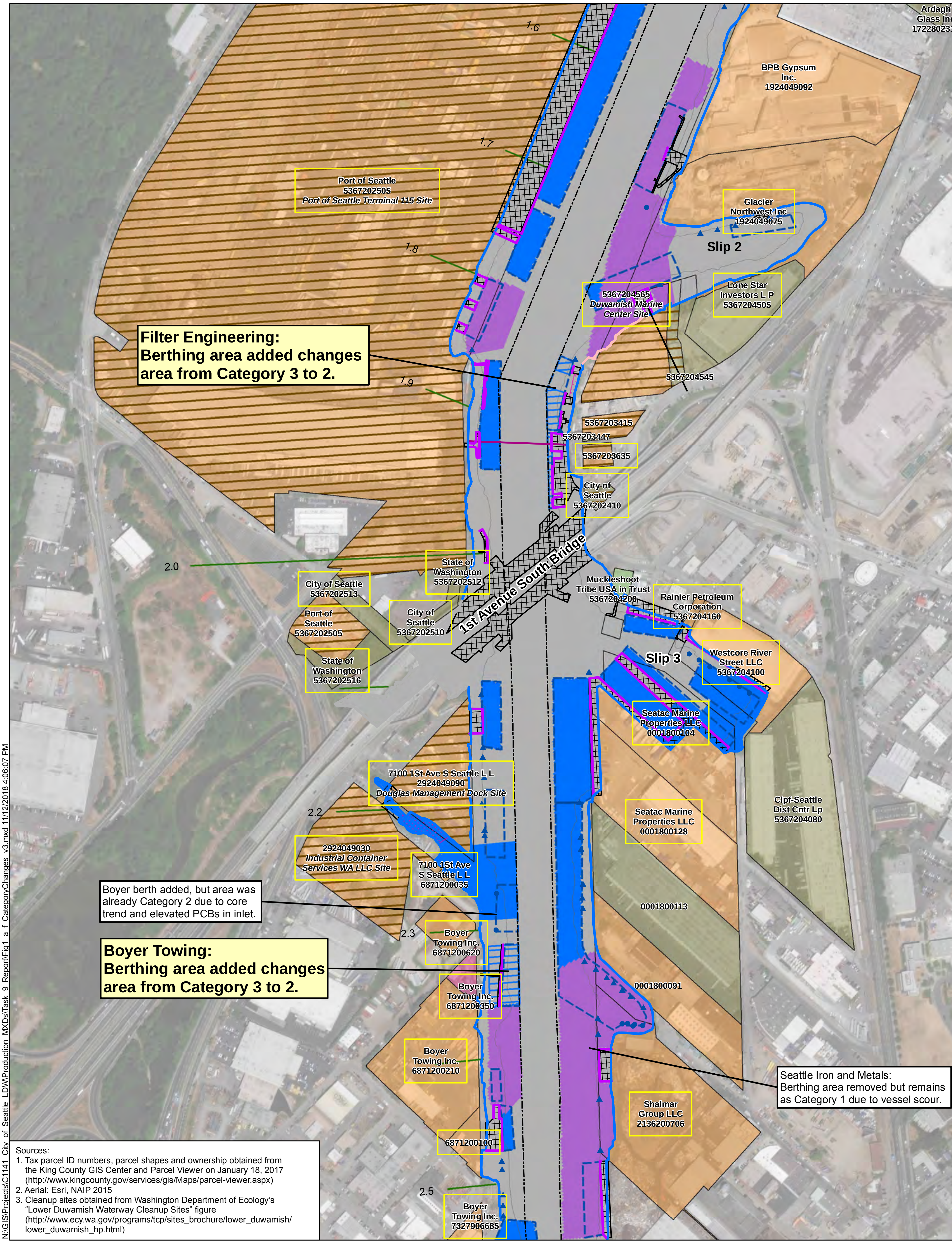
Figure 1b.
Overview of Recommended Recovery Category Changes



Sources:
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2. Aerial: Esri, NAIP 2015
3. Cleanup sites obtained from Washington Department of Ecology's "Lower Duwamish Waterway Cleanup Sites" figure (http://www.ecy.wa.gov/programs/tcp/sites_brochure/lower_duwamish/lower_duwamish_hp.html)

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Recovery Category
- Category 1: Recovery Presumed to be Limited (77 acres)
- Category 2: Recovery Less Certain (44 acres)
- Category 3: Predicted to Recover (229 acres)

Area Changed from Category 3 to 2 (7 acres)

Text

Property Use
- Waterway-Dependent Users
- Recreational Use Businesses/Associations
- Residential and Waterfront Properties without Water-Dependent Facilities
- Tribal Users
- Washington Department of Ecology Cleanup Site
- Early Action Area

- Overwater Structure
- Underwater Utility
- Navigation Channel
- River Mile Marker
- Pile
- Dolphin
- Pile Group
- Berthing Area
- Public Property/Park

Shoreline Structure
- Armored Slope
- Vertical Bulkhead
- Exposed Bank
- Dock Face

0 200 400
Feet

N

Notes:
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2. Annotations are provided only where mapping of recovery categories and/or berthing areas has changed.
3. EAA = Early Action Area
4. Parcel IDs and names outline in yellow indicate a response to the survey.

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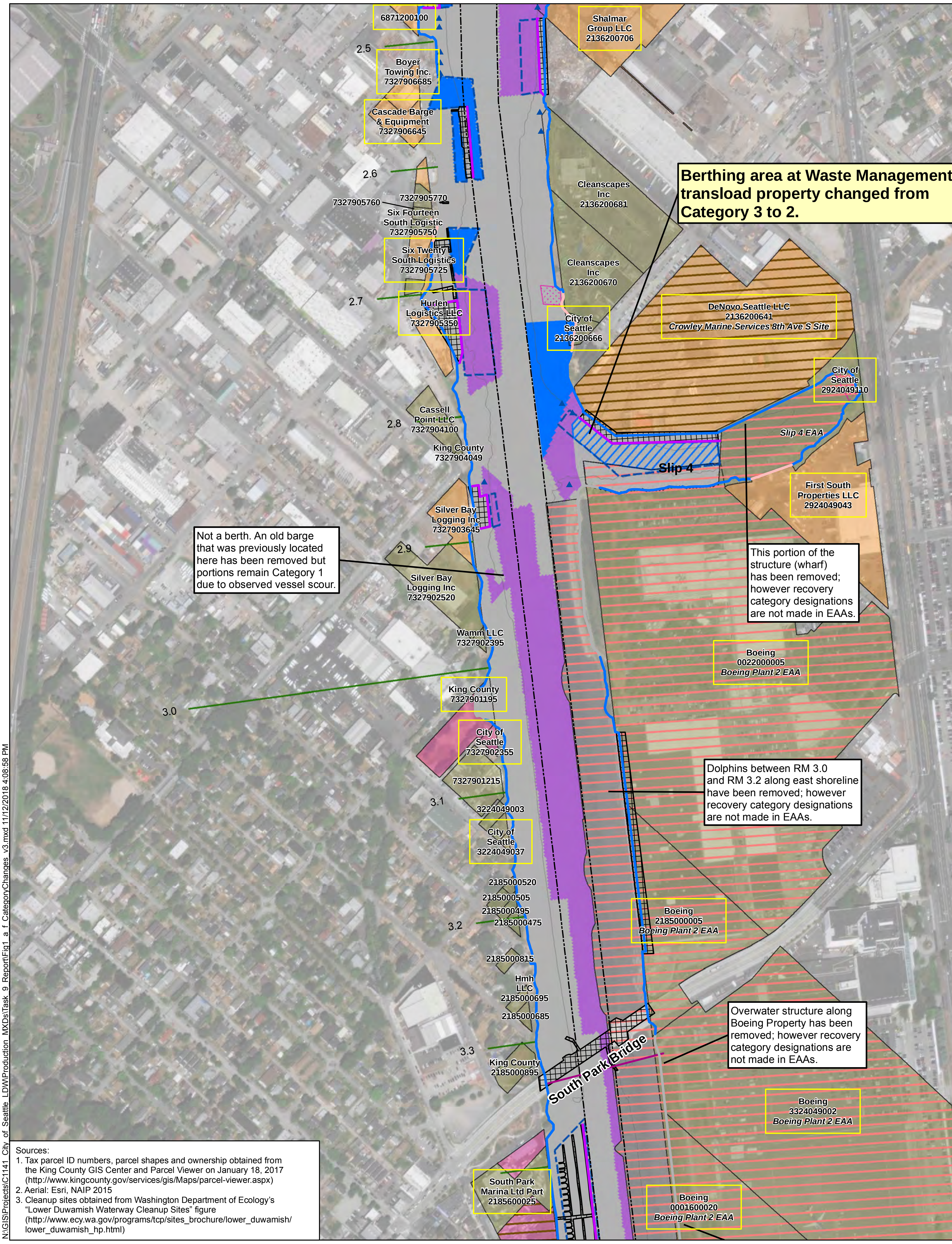
Figure 1c.
Overview of Recommended Recovery Category Changes



Sources:
1. Tax parcel ID numbers, parcel shapes and ownership obtained from the King County GIS Center and Parcel Viewer on January 18, 2017 (http://www.kingcounty.gov/services/gis/Maps/parcel-viewer.aspx)
2. Aerial: Esri, NAIP 2015
3. Cleanup sites obtained from Washington Department of Ecology's "Lower Duwamish Waterway Cleanup Sites" figure (http://www.ecy.wa.gov/programs/tcp/sites_brochure/lower_duwamish/lower_duwamish_hp.html)

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Recovery Category
Category 1: Recovery Presumed to be Limited (77 acres)
Category 2: Recovery Less Certain (44 acres)
Category 3: Predicted to Recover (229 acres)
Area Changed from Category 3 to 2 (7 acres)
Text

Property Use
Waterway-Dependent Users
Recreational Use Businesses/Associations
Residential and Waterfront Properties without Water-Dependent Facilities
Tribal Users
Washington Department of Ecology Cleanup Site
Early Action Area

Overwater Structure
Underwater Utility
Navigation Channel
River Mile Marker
Pile
Dolphin
Pile Group
Berthing Area
Public Property/Park

Shoreline Structure
Armored Slope
Vertical Bulkhead
Exposed Bank
Dock Face

0 200 400
Feet

Notes:
1. Only tax parcel ID numbers are shown at locations where a property is owned by a private party/trust.
2. Annotations are provided only where mapping of recovery categories and/or berthing areas has changed.
3. EAA = Early Action Area
4. Parcel IDs and names outline in yellow indicate a response to the survey.

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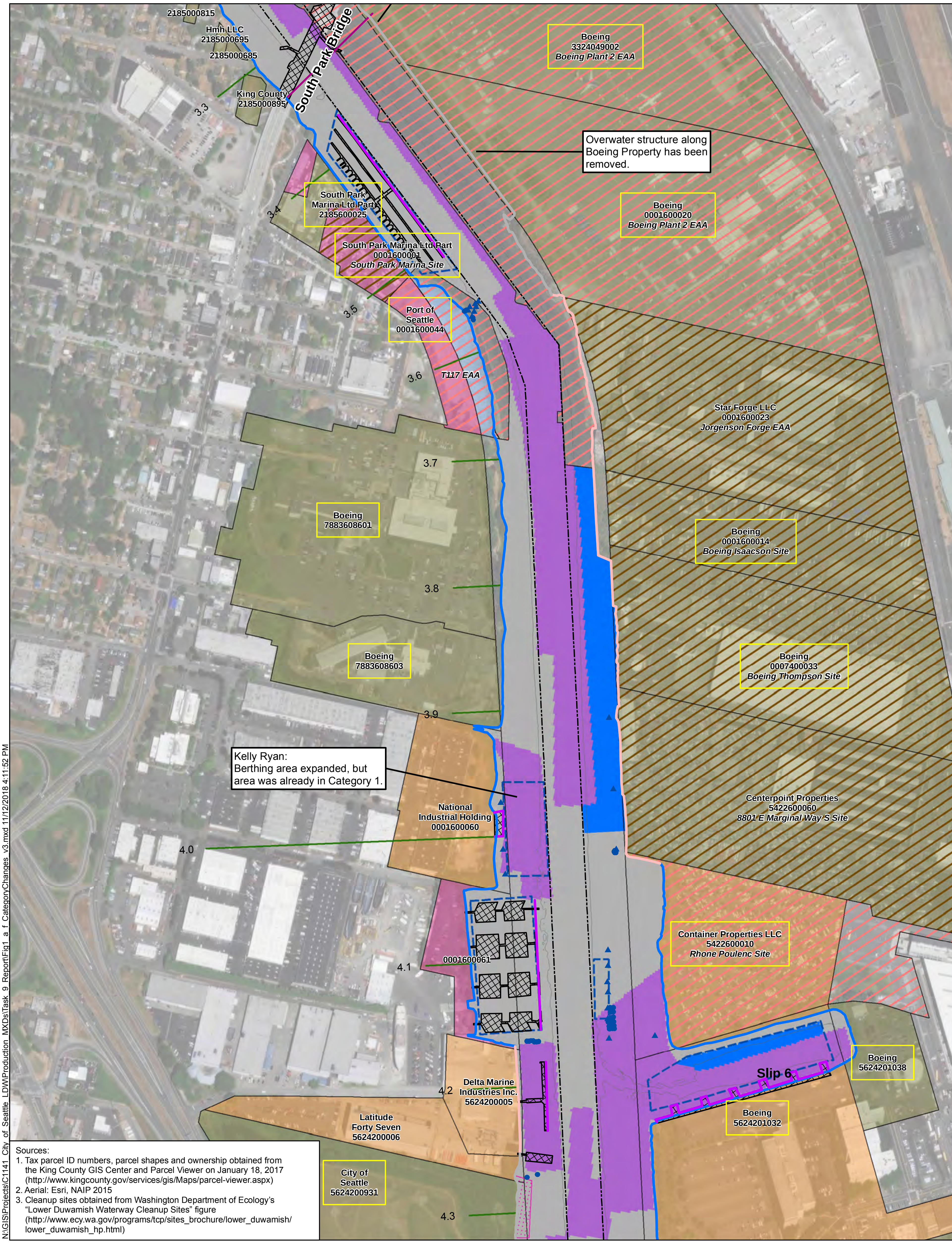
Figure 1d.
Overview of Recommended Recovery Category Changes



Recovery Category
- Category 1: Recovery Presumed to be Limited (77 acres)
- Category 2: Recovery Less Certain (44 acres)
- Category 3: Predicted to Recover (229 acres)

Area Changed from Category 3 to 2 (7 acres)

Text

Property Use
- Waterway-Dependent Users
- Recreational Use Businesses/Associations
- Residential and Waterfront Properties without Water-Dependent Facilities
- Tribal Users
- Washington Department of Ecology Cleanup Site
- Early Action Area

- Overwater Structure
- Underwater Utility
- Navigation Channel
- River Mile Marker
- Pile
- Dolphin
- Pile Group
- Berthing Area
- Public Property/Park

Shoreline Structure
- Armored Slope
- Vertical Bulkhead
- Exposed Bank
- Dock Face

0 200 400
Feet

N

Notes:
1. Only tax parcel ID numbers are shown at locations where a property is owned by a private party/trust.
2. Annotations are provided only where mapping of recovery categories and/or berthing areas has changed.
3. EAA = Early Action Area
4. Parcel IDs and names outline in yellow indicate a response to the survey.

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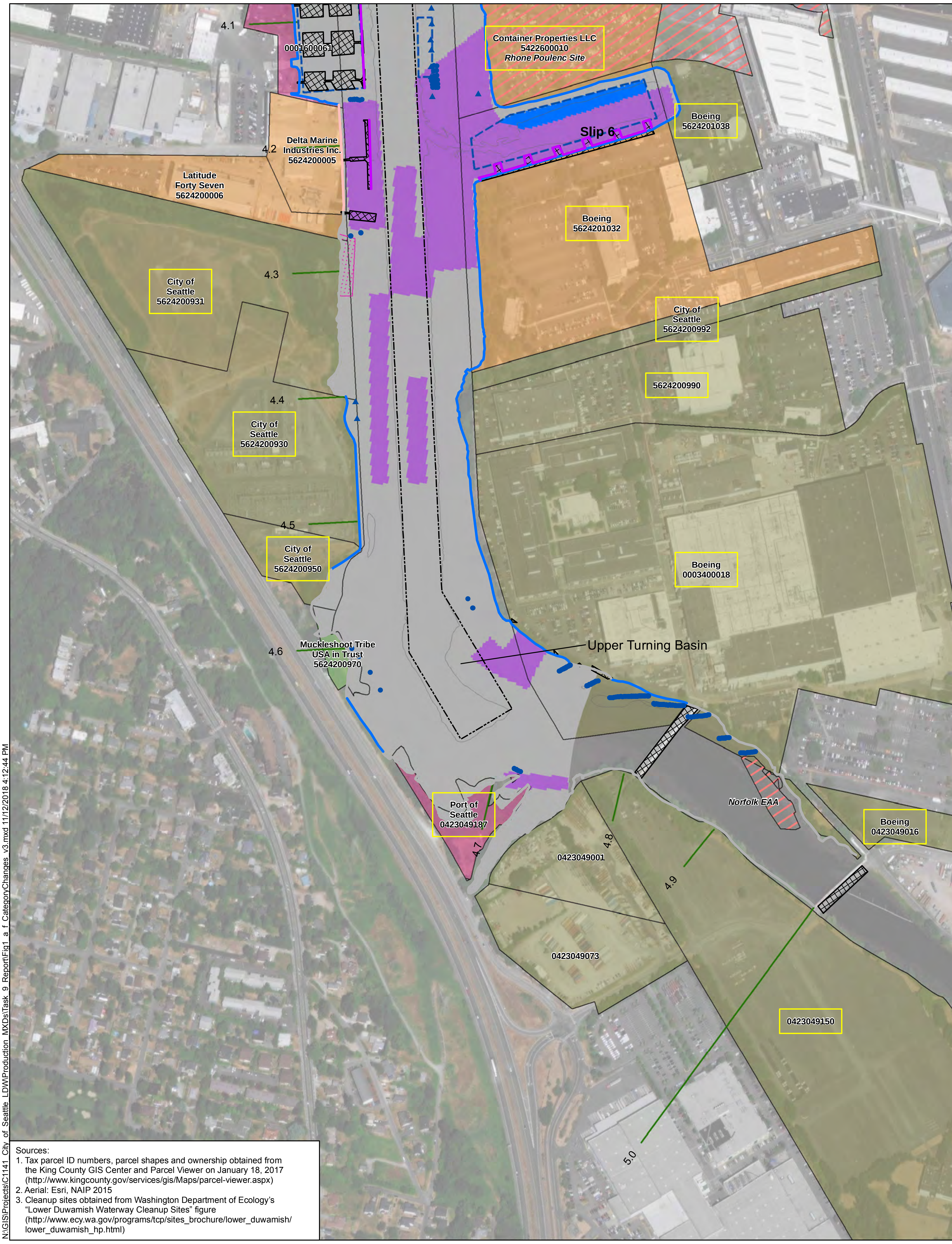
Figure 1e.
Overview of Recommended Recovery Category Changes



Sources:
1. Tax parcel ID numbers, parcel shapes and ownership obtained from the King County GIS Center and Parcel Viewer on January 18, 2017 (http://www.kingcounty.gov/services/gis/Maps/parcel-viewer.aspx)
2. Aerial: Esri, NAIP 2015
3. Cleanup sites obtained from Washington Department of Ecology's "Lower Duwamish Waterway Cleanup Sites" figure (http://www.ecy.wa.gov/programs/tcp/sites_brochure/lower_duwamish/lower_duwamish_hp.html)

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Recovery Category
- Category 1: Recovery Presumed to be Limited (77 acres)
- Category 2: Recovery Less Certain (44 acres)
- Category 3: Predicted to Recover (229 acres)

Area Changed from Category 3 to 2 (7 acres)

Text

Property Use
- Waterway-Dependent Users
- Recreational Use Businesses/Associations
- Residential and Waterfront Properties without Water-Dependent Facilities
- Tribal Users
- Washington Department of Ecology Cleanup Site
- Early Action Area

- Overwater Structure
- Underwater Utility
- Navigation Channel
- River Mile Marker
- Pile
- Dolphin
- Pile Group
- Berthing Area
- Public Property/Park

Shoreline Structure
- Armored Slope
- Vertical Bulkhead
- Exposed Bank
- Dock Face

0 200 400
Feet

N

Notes:
1. Only tax parcel ID numbers are shown at locations where a property is owned by a private party/trust.
2. Annotations are provided only where mapping of recovery categories and/or berthing areas has changed.
3. EAA = Early Action Area
4. Parcel IDs and names outline in yellow indicate a response to the survey.

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Figure 1f.
Overview of Recommended Recovery Category Changes

Notes:
1. See Table 1 for recovery category criteria.
2. The entire FS study area downstream of RM 4.75, except the EAAs, is grouped into recovery categories.
3. Area dredged by Boeing in Slip 4 was added to the EAA layer.

Recovery Category

- Category 1: Recovery Presumed to be Limited (77 acres)
- Category 2: Recovery Less Certain (44 acres)
- Category 3: Predicted to Recover (229 acres)
- Early Action Area (30 acres)

Area Changed from Category 3 to 2 (7 acres)

- Navigation Channel
- River Mile Marker

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0 500 1,000
Feet

Figure 2.
Recovery Category Changes Due to Addition of Berthing Areas
Lower Duwamish Waterway

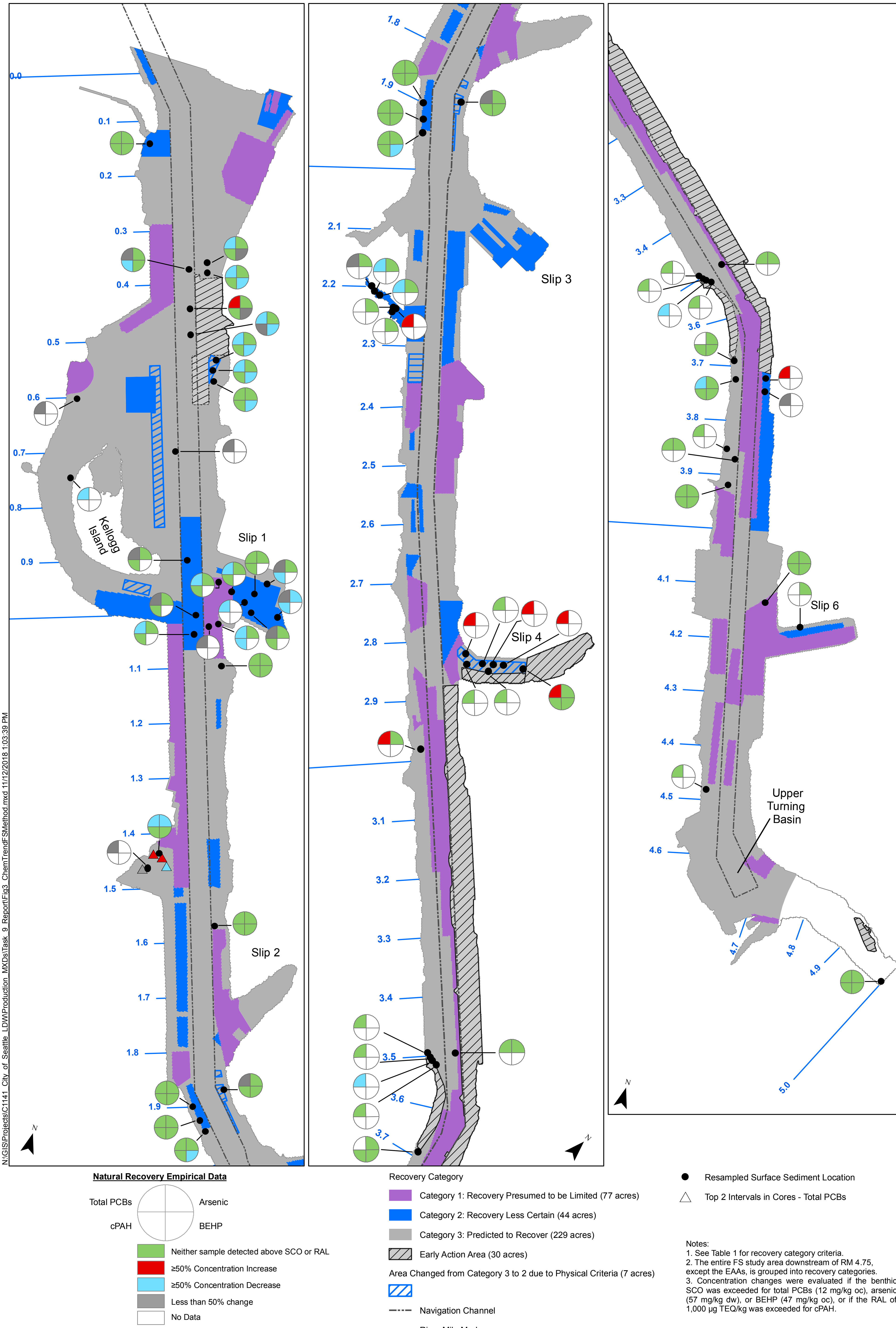

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Figure 3.
Contaminant Trend Data Potentially Informing Recovery Categories
Lower Duwamish Waterway

TABLES

Table 1. Recovery Category Designation Criteria, from the ROD

Criteria		Recovery Categories: Category 1 Recovery Presumed to be Limited	Recovery Categories: Category 2 Recovery Less Certain	Recovery Categories: Category 3 Predicted to Recover
Physical Criteria				
Physical Conditions	Vessel scour	Observed vessel scour	No observed vessel scour	
	Berthing areas	Berthing areas with vessel scour	Berthing areas without vessel scour	Not in a berthing area
Sediment Transport Model	STM-predicted 100-year high-flow scour (depth in cm)	> 10 cm	< 10 cm	
	STM-derived net sedimentation using average flow conditions *	Net scour	Net sedimentation	
Rules for applying criteria		If an area is in Category 1 for any one criterion, that area is designated Category 1	If conditions in an area meet a mixture of Category 2 and 3 criteria, that area is designated Category 2	An area is designated Category 3 only if it meets all Category 3 criteria
Empirical Contaminant Trend Criteria – used on a case-by-case basis to adjust recovery categories that would have been assigned based on physical criteria				
Empirical Contaminant Trend Criteria	Resampled surface sediment locations Sediment cores (top 2 sample intervals in upper 60 cm)	Increasing PCBs or increasing concentrations of other detected COCs that exceed the SCO (> 50% increase)	Equilibrium and mixed (increases and decreases) results (for COCs that exceed the SCO)	Decreasing concentrations (> 50% decrease) or mixed results (decreases and equilibrium)

a. Recovery categories were not assigned to the Early Action Areas, for which remediation should be complete by the time of the remedial actions addressed in this ROD. At the time of the remedial design, EPA will consider assignment of categories to these areas based upon the logic in this table; this information will inform long term monitoring decisions.

Source: Screen grab of Table 23 from ROD (USEPA 2014)

Notes:

* The net sedimentation rate was the calibrated model average sedimentation rate encompassing all measured flow conditions over the 21-year STM calibration period (QEA 2008).

COC = chemical of concern
PCB = polychlorinated biphenyl
ROD = Record of Decision
SCO = sediment cleanup objective (benthic)
STM = sediment transport model

Table 2. Remedial Action Levels, ENR Upper Limits, and Areas and Depths of Application, from the ROD

			Intertidal Sediments (+11.3 ft MLLW to -4 ft MLLW)				Subtidal Sediments (-4 ft MLLW and Deeper)				
			Recovery Category 1 RALs, ENR ULs, and Application Depths		Recovery Category 2 and 3 RALs, ENR ULs, and Application Depths		Recovery Category 1 RALs, ENR ULs, and Application Depths		Recovery Category 2 and 3 RALs, ENR ULs, and Application Depths		Shoaled Areas[b] in Federal Navigation Channel
Risk Driver COC	**Units**	**Action Levels**	Top 10 cm (4 in)	Top 45 cm (1.5 ft)	Top 10 cm (4 in)	Top 45 cm (1.5 ft)	Top 10 cm (4 in)	Top 60 cm (2 ft)	Top 10 cm (4 in)	Top 60 cm (2 ft)[c]	Top to Authorized Navigation Depth Plus 2 ft
Human Health Based RALs											
PCBs (Total)	mg/kg OC	RAL	12	12	12	65	12	12	12	195	12
		UL[a] for ENR	–	–	36	97	–	–	36	195	--
Arsenic (Total)	mg/kg dw	RAL	57	28	57	28	57	57	57	–	57
		UL[a] for ENR	–	–	171	42	–	–	171	–	--
cPAH	µg TEQ/kg dw	RAL	1000	900	1000	900	1000	1000	1000	–	1000
		UL[a] for ENR	–	–	3000	1350	–	–	3000	–	--
Dioxins/Furans	ng TEQ/kg dw	RAL	25	28	25	28	25	25	25	–	25
		UL[a] for ENR	–	–	75	42	–	–	75	–	--
Benthic Protection RALs											
39 SMS COCs[d]	Contaminant-specific	RAL	Benthic SCO	Benthic SCO	2x Benthic SCO	–	Benthic SCO	Benthic SCO	2x Benthic SCO	–	Benthic SCO
		UL[a] for ENR	–	–	3x RAL	–	–	–	3x RAL	–	--

Source: Table 28 from ROD (USEPA 2014).

Notes:

ENR = enhanced natural recovery

ROD = Record of Decision

Table 3a. Resampled Surface Sediment—Total PCBs

	FS Data								Post-FS New Data										Location Trend		
RM	Location Name	Sample Date	Total PCBs (µg/kg dw)	Qualifier	Detected?	Exceeds SCO?	Exceeds CSL?	Detected Above SCO?	Task Description - Resampling	Location Name	Sample Name	Sample Date	Total PCBs (µg/kg dw)	Qualifier	Detected?	Exceeds SCO?	Exceeds CSL?	Detected Above SCO?	Either Detected Above SCO?	Percent Change	Trend Code for Mapping
0.1	LDW-SS306	10/3/2006	8.4	J	Yes	No	No	No	LDW outfall sediment survey	LDW-SS2233-U	LDW-SS2233-U	4/20/2011	28		Yes	No	No	No	No	233%	green
0.6	DR010	9/14/1998	74		Yes	No	No	No	LDW AOC3 in-water sediment sampling 2018	LDW18-SS-170	LDW18-SS-170	3/1/2018	56.3	J	Yes	No	No	No	No	-24%	green
0.6	DUD040	11/9/1995	620	J	Yes	Yes	No	Yes		LDW18-SS-171	LDW18-SS-171	3/1/2018	162.9		Yes	No	No	No	Yes	-74%	blue
0.6	LDW-SS312	10/3/2006	1010		Yes	Yes	Yes	Yes		LDW18-SS-172	LDW18-SS-172	3/1/2018	743	J	Yes	Yes	No	Yes	Yes	-26%	gray
0.7	DR083	8/31/1998	567	J	Yes	Yes	No	Yes		LDW18-SS-173	LDW18-SS-173	3/1/2018	396		Yes	Yes	No	Yes	Yes	-30%	gray
0.7	WIT288	9/15/1997	340		Yes	Yes	No	Yes		LDW18-SS-174	LDW18-SS-174	3/1/2018	49.1	J	Yes	No	No	No	Yes	-86%	blue
0.9	LDW-SS318	10/4/2006	212	J	Yes	Yes	No	Yes	Slip 1 Sediment Sampling May/June 2015	27	SL1-SS-SD-G027	6/2/2015	130		Yes	No	No	No	Yes	-39%	gray
0.9	LDW-SS319	10/4/2006	350		Yes	Yes	No	Yes		24	SL1-SS-SD-G024	6/3/2015	127		Yes	No	No	No	Yes	-64%	blue
1	B3b	8/17/2004	350		Yes	Yes	No	Yes		46	SL1-SS-SD-G046	6/4/2015	500		Yes	Yes	No	Yes	Yes	43%	gray
1	DR017	8/17/1998	121	J	Yes	No	No	No		38	SL1-SS-SD-G038	6/4/2015	160		Yes	Yes	No	Yes	Yes	32%	gray
1	DR018	9/2/1998	265	J	Yes	No	No	No		35	SL1-SS-SD-G035	6/3/2015	127		Yes	No	No	No	No	-52%	green
1	EST214	10/22/1997	700	J	Yes	Yes	No	Yes		34	SL1-SS-SD-G034	6/2/2015	208		Yes	No	No	No	Yes	-70%	blue
1	EST215	10/14/1997	110		Yes	No	No	No		5	SL1-SS-SD-G005	6/2/2015	132	J	Yes	Yes	No	Yes	Yes	20%	gray
1	LDW-SS32	1/18/2005	122	J	Yes	No	No	No		36	SL1-SS-SD-G036	6/1/2015	162		Yes	Yes	No	Yes	Yes	33%	gray
1	LDW-SS320	10/4/2006	390	J	Yes	Yes	No	Yes		30	SL1-SS-SD-G030	6/3/2015	104		Yes	No	No	No	Yes	-73%	blue
1	LDW-SS321	10/4/2006	450	J	Yes	Yes	No	Yes	LDW AOC3 in-water sediment sampling 2018	LDW18-SS-176	LDW18-SS-176	3/1/2018	354		Yes	Yes	No	Yes	Yes	-21%	gray
1			450	J	Yes	Yes	No	Yes	Slip 1 Sediment Sampling May/June 2015	2	SL1-SS-SD-G002	6/2/2015	93		Yes	No	No	No	Yes	-79%	blue
1	LDW-SS35	3/8/2005	650		Yes	Yes	No	Yes		9	SL1-SS-SD-G009	6/4/2015	176		Yes	No	No	No	Yes	-73%	blue
1	LDW-SS37	1/18/2005	5100		Yes	Yes	Yes	Yes		1	SL1-SS-SD-G001	6/2/2015	300		Yes	Yes	No	Yes	Yes	-94%	blue
1.1	WQABRAN	6/3/1997	137.7		Yes	No	No	No	King County CSO Sediment Quality Characterization 2011	CSO-BR-5	L53963-42	8/29/2011	108.2		Yes	No	No	No	No	-21%	green
1.4	LDW-SS56	1/24/2005	750	J	Yes	Yes	Yes	Yes	Glacier Northwest - Reichhold RI/FS	SED-SS-22	SED-SS-22-052312	5/23/2012	280		Yes	Yes	No	Yes	Yes	-63%	blue
1.5	LDW-SS57	1/24/2005	750		Yes	Yes	No	Yes	LDW AOC3 in-water sediment sampling 2018	LDW18-SS-177	LDW18-SS-177	3/2/2018	450		Yes	Yes	No	Yes	Yes	-40%	gray
1.6	DR092	8/27/1998	64		Yes	No	No	No		LDW18-SS-178	LDW18-SS-178	3/1/2018	242.4		Yes	No	No	No	No	279%	green
1.6			64		Yes	No	No	No		LDW18-SS-178	LDW18-SS-178-FD	3/1/2018	241		Yes	No	No	No	No	277%	green
1.9	DR155	8/13/1998	106	J	Yes	No	No	No		LDW18-SS-183	LDW18-SS-183	3/2/2018	197.3		Yes	No	No	No	No	86%	green
1.9	LDW-SS69b	3/16/2005	340		Yes	Yes	No	Yes	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	3/24/2011	370		Yes	Yes	No	Yes	Yes	9%	gray
1.9	LDW-SS72	1/24/2005	82	J	Yes	No	No	No		LDW-SSPSF-D	LDW-SSPSF-D	3/7/2011	46		Yes	No	No	No	No	-44%	green
1.9	R5	10/15/1997	159	J	Yes	No	No	No		LDW-SS2122-D	LDW-SS2122-D	3/8/2011	45		Yes	No	No	No	No	-72%	green
2.2	DR139	9/14/1998	2840		Yes	Yes	Yes	Yes	LDW AOC3 in-water sediment sampling 2018	LDW18-SS-181	LDW18-SS-181	2/28/2018	6900		Yes	Yes	Yes	Yes	Yes	143%	red
2.2	EAA2-SED-1	5/4/2007	2900000		Yes	Yes	Yes	Yes	Industrial Container Services (EAA 2)	SED1	ICS-SED1-SE-091914	9/19/2014	1600000		Yes	Yes	Yes	Yes	Yes	-45%	gray
2.2	EAA2-SED-2	5/4/2007	230000		Yes	Yes	Yes	Yes	Industrial Container Services (EAA 2)	SED2	ICS-SED2-SE-091914	9/19/2014	36000		Yes	Yes	Yes	Yes	Yes	-84%	blue
2.2	LDW-SS84	1/19/2005	23000		Yes	Yes	Yes	Yes	Industrial Container Services (EAA 2)	LDWSS84	ICS-LDWSS84-SE-091914	9/19/2014	6400		Yes	Yes	Yes	Yes	Yes	-72%	blue
2.8	DR179	8/24/1998	3400	J	Yes	Yes	Yes	Yes	City of Seattle Slip 4 Long Term Monitoring (Year 5)	WC-4	SL4-SD0125	7/24/2017	42.6	J	Yes	No	No	No	Yes	-99%	blue
2.8			3400	J	Yes	Yes	Yes	Yes	Slip 4 Long-Term Monitoring Year 1	WC-4	SD0104	7/22/2013	39		Yes	No	No	No	Yes	-99%	blue
2.8			3400	J	Yes	Yes	Yes	Yes	Slip 4 EAA Removal Action Completion	WC-4	SD0028	1/30/2012	3.8		Yes	No	No	No	Yes	-100%	blue

Table 3a. Resampled Surface Sediment—Total PCBs

	FS Data								Post-FS New Data										Location Trend		
RM	Location Name	Sample Date	Total PCBs (µg/kg dw)	Qualifier	Detected?	Exceeds SCO?	Exceeds CSL?	Detected Above SCO?	Task Description - Resampling	Location Name	Sample Name	Sample Date	Total PCBs (µg/kg dw)	Qualifier	Detected?	Exceeds SCO?	Exceeds CSL?	Detected Above SCO?	Either Detected Above SCO?	Percent Change	Trend Code for Mapping
2.8	SG18	4/8/2004	130	N	Yes	No	No	No	Boeing Plant 2 Perimeter monitoring - End of Season 2015 (Event 7)	SD-PER510	SD-PER510-0315	3/11/2015	300		Yes	Yes	No	Yes	Yes	131%	red
2.8			130	N	Yes	No	No	No	Boeing Plant 2 Perimeter monitoring - Pre-dredge 2014 (Event 6)	SD-PER510	SD-PER510-0914	9/10/2014	300		Yes	No	No	No	No	131%	green
2.8			130	N	Yes	No	No	No	Boeing Plant 2 Perimeter monitoring - End of Season 2013 (Event 2)	SD-PER510	SD-PER510-0313	3/5/2013	310		Yes	Yes	No	Yes	Yes	138%	red
2.8			130	N	Yes	No	No	No	Slip 4 8th Avenue Terminals	SG18	SD0058	10/31/2012	620		Yes	Yes	No	Yes	Yes	377%	red
2.8	SG20	4/8/2004	179	JN	Yes	No	No	No	Boeing Plant 2 Perimeter monitoring - End of Season 2015 (Event 7)	SD-PER513	SD-PER513-0315	3/11/2015	550		Yes	Yes	No	Yes	Yes	207%	red
2.8			179	JN	Yes	No	No	No	Boeing Plant 2 Perimeter monitoring - Pre-dredge 2014 (Event 6)	SD-PER513	SD-PER513-0914	9/10/2014	350		Yes	Yes	No	Yes	Yes	96%	red
2.8			179	JN	Yes	No	No	No	Boeing Plant 2 Perimeter monitoring - End of Season 2013 (Event 2)	SD-PER513	SD-PER513-0313	3/5/2013	360		Yes	Yes	No	Yes	Yes	101%	red
2.8			179	JN	Yes	No	No	No	Slip 4 8th Avenue Terminals	SG20	SD0059	10/31/2012	320		Yes	Yes	No	Yes	Yes	79%	red
2.8	SG21	4/8/2004	158	N	Yes	No	No	No	Boeing Plant 2 Perimeter monitoring - End of Season 2015 (Event 7)	SD-PER515	SD-PER515-0315	3/13/2015	310		Yes	No	No	No	No	96%	green
2.8			158	N	Yes	No	No	No	Boeing Plant 2 Perimeter monitoring - Pre-dredge 2014 (Event 6)	SD-PER515	SD-PER515-0914	9/12/2014	260		Yes	No	No	No	No	65%	green
2.8			158	N	Yes	No	No	No	Boeing Plant 2 Perimeter monitoring - End of Season 2013 (Event 2)	SD-PER515	SD-PER515-0313	3/5/2013	250		Yes	Yes	No	Yes	Yes	58%	red
2.8			158	N	Yes	No	No	No	Slip 4 8th Avenue Terminals	SG21	SD0060	10/30/2012	140		Yes	No	No	No	No	-11%	green
2.8	SG24	4/9/2004	99	N	Yes	No	No	No	Boeing Plant 2 Perimeter monitoring - End of Season 2015 (Event 7)	SD-PER518	SD-PER518-0315	3/12/2015	240	J	Yes	Yes	No	Yes	Yes	142%	red
2.8			99	N	Yes	No	No	No	Boeing Plant 2 Perimeter monitoring - Pre-dredge 2014 (Event 6)	SD-PER518	SD-PER518-0914	9/11/2014	290		Yes	No	No	No	No	193%	green
2.8			99	N	Yes	No	No	No	Boeing Plant 2 Perimeter monitoring - End of Season 2013 (Event 2)	SD-PER518	SD-PER518-0313	3/7/2013	330		Yes	Yes	No	Yes	Yes	233%	red
2.8	SG25	4/9/2004	116	JN	Yes	No	No	No	Boeing Plant 2 Perimeter monitoring - End of Season 2015 (Event 7)	SD-PER517	SD-PER517-0315	3/13/2015	260		Yes	No	No	No	No	124%	green
2.8			116	JN	Yes	No	No	No	Boeing Plant 2 Perimeter monitoring - Pre-dredge 2014 (Event 6)	SD-PER517	SD-PER517-0914	9/12/2014	230		Yes	No	No	No	No	98%	green
2.8			116	JN	Yes	No	No	No	Boeing Plant 2 Perimeter monitoring - End of Season 2013 (Event 2)	SD-PER517	SD-PER517-0313	3/7/2013	280		Yes	Yes	No	Yes	Yes	141%	red
2.9	DR180	8/24/1998	527	J	Yes	Yes	No	Yes	Slip 4 EAA Removal Action Completion	BD-7	SD0053	2/14/2012	3.8	U	No	No	No	No	Yes	-99%	blue
2.9			527	J	Yes	Yes	No	Yes			SD0047	2/1/2012	680		Yes	Yes	No	Yes	Yes	29%	gray
2.9			527	J	Yes	Yes	No	Yes			SD0008	8/24/2011	240		Yes	Yes	No	Yes	Yes	-54%	blue
2.9	DR-181	8/10/2006	460	J	Yes	Yes	No	Yes			SD0042	2/2/2012	760		Yes	Yes	No	Yes	Yes	65%	red
2.9			460	J	Yes	Yes	No	Yes			SD0002	8/24/2011	350		Yes	Yes	No	Yes	Yes	-24%	gray

Table 3a. Resampled Surface Sediment—Total PCBs

	FS Data								Post-FS New Data										Location Trend		
RM	Location Name	Sample Date	Total PCBs (µg/kg dw)	Qualifier	Detected?	Exceeds SCO?	Exceeds CSL?	Detected Above SCO?	Task Description - Resampling	Location Name	Sample Name	Sample Date	Total PCBs (µg/kg dw)	Qualifier	Detected?	Exceeds SCO?	Exceeds CSL?	Detected Above SCO?	Either Detected Above SCO?	Percent Change	Trend Code for Mapping
2.9	EIT-066	8/10/2006	3200	J	Yes	Yes	Yes	Yes	Boeing Plant 2 Post-construction surface sed monitoring Year 1	SD-PCM010	SD-PCM01016	3/9/2016	46		Yes	No	No	No	Yes	-99%	blue
2.9			3200	J	Yes	Yes	Yes	Yes	Boeing Plant 2 Post-construction surface sed monitoring Year 0	SD-PCM010	SD-PCM01015	3/11/2015	3.8	U	No	No	No	No	Yes	-100%	blue
2.9	SG17	4/8/2004	119		Yes	No	No	No	Slip 4 EAA Removal Action Completion	BD-8	SD0055	2/14/2012	3.8	U	No	No	No	No	No	-97%	green
2.9	SG22	4/8/2004	145	N	Yes	No	No	No	Boeing Plant 2 Perimeter monitoring - End of Season 2015 (Event 7)	SD-PER514	SD-PER514-0315	3/13/2015	270		Yes	No	No	No	No	86%	green
2.9			145	N	Yes	No	No	No	Boeing Plant 2 Perimeter monitoring - Pre-dredge 2014 (Event 6)	SD-PER514	SD-PER514-0914	9/12/2014	250		Yes	Yes	No	Yes	Yes	72%	red
2.9			145	N	Yes	No	No	No	Boeing Plant 2 Perimeter monitoring - End of Season 2013 (Event 2)	SD-PER514	SD-PER514-0313	3/6/2013	310		Yes	Yes	No	Yes	Yes	114%	red
2.9			145	N	Yes	No	No	No	Slip 4 8th Avenue Terminals	SG22	SD0061	10/30/2012	170		Yes	No	No	No	No	17%	green
2.9	SG30	6/21/2006	520		Yes	Yes	No	Yes	Slip 4 EAA Removal Action Completion	BD-4	SD0057	2/14/2012	3.8	U	No	No	No	No	Yes	-99%	blue
2.9			520		Yes	Yes	No	Yes	Slip 4 EAA Removal Action Completion	BD-4	SD0005	8/24/2011	530		Yes	Yes	No	Yes	Yes	2%	gray
2.9	SG33	6/21/2006	360		Yes	Yes	No	Yes	Slip 4 EAA Removal Action Completion	BD-8	SD0009	8/24/2011	280		Yes	Yes	No	Yes	Yes	-22%	gray
3	LDW-SS99	1/19/2005	20	U	No	No	No	No	Boeing Plant 2 Perimeter monitoring - End of Season 2015 (Event 7)	SD-PER206	SD-PER206-0315	3/18/2015	93		Yes	Yes	No	Yes	Yes	365%	red
3			20	U	No	No	No	No	Boeing Plant 2 Perimeter monitoring - Pre-dredge 2014 (Event 6)	SD-PER206	SD-PER206-0914	9/17/2014	83		Yes	No	No	No	No	315%	green
3			20	U	No	No	No	No	Boeing Plant 2 Perimeter monitoring - End of Season 2014 (Event 4)	SD-PER206	SD-PER206-0314	3/14/2014	81		Yes	No	No	No	No	305%	green
3			20	U	No	No	No	No	Boeing Plant 2 Perimeter monitoring - Pre-dredge 2013 (Event 3)	SD-PER206	SD-PER206-1213	12/12/2013	166		Yes	Yes	No	Yes	Yes	730%	red
3			20	U	No	No	No	No	Boeing Plant 2 Perimeter monitoring - End of Season 2013 (Event 2)	SD-PER206	SD-PER206-0313	3/11/2013	95		Yes	No	No	No	No	375%	green
3			20	U	No	No	No	No	Boeing Plant 2 Perimeter monitoring - Pre-dredge 2012 (Event 1)	SD-PER206	SD-PER206-1212	12/5/2012	63		Yes	No	No	No	No	215%	green
3.1	SD-DUW29	10/25/1995	640		Yes	Yes	No	Yes	Boeing Plant 2 DSOA Backfill Additional Sampling	SD-DMS6-2	SD-DMS6-2-1215-A	12/18/2015	67		Yes	No	No	No	Yes	-90%	blue

Table 3a. Resampled Surface Sediment—Total PCBs

	FS Data								Post-FS New Data										Location Trend		
RM	Location Name	Sample Date	Total PCBs (µg/kg dw)	Qualifier	Detected?	Exceeds SCO?	Exceeds CSL?	Detected Above SCO?	Task Description - Resampling	Location Name	Sample Name	Sample Date	Total PCBs (µg/kg dw)	Qualifier	Detected?	Exceeds SCO?	Exceeds CSL?	Detected Above SCO?	Either Detected Above SCO?	Percent Change	Trend Code for Mapping
3.5	100-G	8/29/2008	59		Yes	No	No	No	T-117 Outfall Pre-operation Sediment	T117-SG-C3	SD0125	7/12/2016	70	J	Yes	No	No	No	No	19%	green
3.5			59		Yes	No	No	No	T-117 Outfall Pre-operation Sediment	T117-SG-C2	SD0124	7/12/2016	64	J	Yes	No	No	No	No	8%	green
3.5			59		Yes	No	No	No	Terminal 117 Outfall Post-construction Sediment Sampling	T117-SG-C2-PostCon	T117OF_SD0117	8/10/2015	104		Yes	No	No	No	No	76%	green
3.5			59		Yes	No	No	No	Terminal 117 Outfall Post-construction Sediment Sampling	T117-SG-C3-PostCon	T117OF_SD0118	8/10/2015	87		Yes	No	No	No	No	47%	green
3.5			59		Yes	No	No	No	LDW outfall sediment survey	LDW-SS2214-U	LDW-SS2214-U	3/7/2011	410		Yes	Yes	No	Yes	Yes	595%	red
3.5	98-G	8/29/2008	118		Yes	No	No	No	LDW outfall sediment survey	LDW-SS2214-A	LDW-SS2214-A	3/7/2011	290		Yes	No	No	No	No	146%	green
3.5	SD-DUW82	4/3/1996	142	J	Yes	No	No	No	Boeing Plant 2 Perimeter monitoring - End of Season 2015 (Event 7)	SD-PER306	SD-PER306-0315	2/27/2015	160		Yes	No	No	No	No	13%	green
3.5			142	J	Yes	No	No	No	Boeing Plant 2 Perimeter monitoring - Pre-dredge 2014 (Event 6)	SD-PER306	SD-PER306-0914	9/15/2014	157	J	Yes	No	No	No	No	11%	green
3.5			142	J	Yes	No	No	No	Boeing Plant 2 Perimeter monitoring - Pre-SW Bank Excavation 2014 (Event 5)	SD-PER306	SD-PER306-0714	7/14/2014	143		Yes	Yes	No	Yes	Yes	1%	gray
3.5			142	J	Yes	No	No	No	Boeing Plant 2 Perimeter monitoring - Pre-dredge 2013 (Event 3)	SD-PER306	SD-PER306-1213	12/19/2013	160		Yes	No	No	No	No	13%	green
3.5			142	J	Yes	No	No	No	Boeing Plant 2 Perimeter monitoring - Pre-dredge 2012 (Event 1)	SD-PER306	SD-PER306-1212	12/10/2012	78		Yes	No	No	No	No	-45%	green
3.5	T117-SE-89-G	9/14/2004	660		Yes	Yes	No	Yes	T-117 Outfall Pre-operation Sediment	T117-SG-B1	SD0123	7/12/2016	64	J	Yes	No	No	No	Yes	-90%	blue
3.5			660		Yes	Yes	No	Yes	Terminal 117 Outfall Post-construction Sediment Sampling	T117-SG-B1-PostCon	T117OF_SD0113	8/10/2015	119		Yes	No	No	No	Yes	-82%	blue
3.5	T117-SE-91-G	9/14/2004	128		Yes	No	No	No	Terminal 117 Outfall Post-construction Sediment Sampling	T117-SG-A2-PostCon	T117OF_SD0111	8/10/2015	108	J	Yes	No	No	No	No	-16%	green
3.5			128		Yes	No	No	No	Terminal 117 Outfall Post-construction Sediment Sampling	T117-SG-A3-PostCon	T117OF_SD0112	8/10/2015	96		Yes	No	No	No	No	-25%	green
3.6	SD-330-S	8/27/2004	680	J	Yes	Yes	No	Yes	Boeing Plant 2 Jorgensen Backfill - Post-DSOA dredge 2014	SD-JOR02	SD-JOR02-0315	3/6/2015	310		Yes	Yes	No	Yes	Yes	-54%	blue
3.6	SD-330-S	8/27/2004	680	J	Yes	Yes	No	Yes	Boeing Plant 2 Jorgensen Backfill - Pre-DSOA dredge 2014	SD-JOR02	SD-JOR02-1114	11/24/2014	170		Yes	No	No	No	Yes	-75%	blue
3.6	SD-DUW161	8/20/2003	12900		Yes	Yes	Yes	Yes	Boeing Plant 2 Post-construction surface sed monitoring Year 0	SD-PCM009	SD-PCM00915	2/25/2015	4	U	No	No	No	No	Yes	-100%	blue
3.6	SD-DUW72	4/3/1996	240		Yes	No	No	No		SD-DMS13-1	SD-DMS13-1-0915-A	9/10/2015	290		Yes	Yes	No	Yes	Yes	21%	gray

Table 3a. Resampled Surface Sediment—Total PCBs

	FS Data								Post-FS New Data										Location Trend		
RM	Location Name	Sample Date	Total PCBs (µg/kg dw)	Qualifier	Detected?	Exceeds SCO?	Exceeds CSL?	Detected Above SCO?	Task Description - Resampling	Location Name	Sample Name	Sample Date	Total PCBs (µg/kg dw)	Qualifier	Detected?	Exceeds SCO?	Exceeds CSL?	Detected Above SCO?	Either Detected Above SCO?	Percent Change	Trend Code for Mapping
3.6	SD-DUW73	4/3/1996	390	J	Yes	Yes	No	Yes	Boeing Plant 2 DSOA Backfill Additional Sampling	SD-DMS15-1	SD-DMS15-1-0216-A	2/11/2016	90		Yes	No	No	No	Yes	-77%	blue
3.6			390	J	Yes	Yes	No	Yes		SD-DMS15-1	SD-DMS15-1-0116-A	1/12/2016	69		Yes	No	No	No	Yes	-82%	blue
3.6			390	J	Yes	Yes	No	Yes		SD-DMS15-1	SD-DMS15-1-1215-A	12/19/2015	121		Yes	No	No	No	Yes	-69%	blue
3.6			390	J	Yes	Yes	No	Yes		SD-DMS15-1	SD-DMS15-1-1115	11/11/2015	102		Yes	No	No	No	Yes	-74%	blue
3.6			390	J	Yes	Yes	No	Yes		SD-DMS15-1	SD-DMS15-1-1015-A	10/8/2015	220	J	Yes	No	No	No	Yes	-44%	gray
3.6			390	J	Yes	Yes	No	Yes		SD-DMS15-1	SD-DMS15-1-0915-A	9/10/2015	230	JN	Yes	No	No	No	Yes	-41%	gray
3.6			390	J	Yes	Yes	No	Yes		SD-DMS15-1	SD-DMS15-1-0815-A	8/11/2015	240	J	Yes	Yes	No	Yes	Yes	-38%	gray
3.6			390	J	Yes	Yes	No	Yes		SD-DMS15-1	SD-DMS15-1-0715-A	7/8/2015	186	J	Yes	Yes	No	Yes	Yes	-52%	blue
3.6			390	J	Yes	Yes	No	Yes		SD-DMS15-1	SD-DMS15-1-0615-A	6/9/2015	172		Yes	No	No	No	Yes	-56%	blue
3.6			390	J	Yes	Yes	No	Yes		SD-DMS15-1	SD-DMS15-1-0415A	4/28/2015	68		Yes	No	No	No	Yes	-83%	blue
3.7	EST161	11/13/1997	160		Yes	Yes	No	Yes	Isaacson-Thompson RI Sediment	SD-502G	SD-502G	2/6/2012	410		Yes	Yes	No	Yes	Yes	156%	red
3.7	R20	10/10/1997	170		Yes	Yes	No	Yes	LDW AOC3 in-water sediment sampling 2018	LDW18-SS-187	LDW18-SS-187	3/2/2018	65.3		Yes	No	No	No	Yes	-62%	blue
3.7	SD-336-S	8/27/2004	250	J	Yes	Yes	No	Yes	LDW AOC3 in-water sediment sampling 2018	LDW18-SS-185	LDW18-SS-185	2/28/2018	253	J	Yes	Yes	No	Yes	Yes	1%	gray
3.9	DR258	8/25/1998	62		Yes	No	No	No	LDW AOC3 in-water sediment sampling 2018	LDW18-SS-186	LDW18-SS-186	2/28/2018	56.5	JN	Yes	No	No	No	No	-9%	green
3.9	R29	10/9/1997	52		Yes	No	No	No	Boeing Plant 2 Perimeter monitoring - Pre-dredge 2014 (Event 6)	SD-PER404	SD-PER404-0914	9/19/2014	119		Yes	No	No	No	No	129%	green
3.9			52		Yes	No	No	No	Boeing Plant 2 Perimeter monitoring - Pre-SW Bank Excavation 2014 (Event 5)	SD-PER404	SD-PER404-0714	7/16/2014	61	J	Yes	No	No	No	No	17%	green
3.9			52		Yes	No	No	No	Boeing Plant 2 Perimeter monitoring - End of Season 2014 (Event 4)	SD-PER404	SD-PER404-0314	3/24/2014	72		Yes	No	No	No	No	38%	green
3.9	WIT262	10/16/1997	17	J	Yes	No	No	No	LDW outfall sediment survey	LDW-SSSP2-D	LDW-SSSP2-D	3/24/2011	13.5		Yes	No	No	No	No	-21%	green
4.1	DR239	8/27/1998	22		Yes	No	No	No	Former Rhone Poulenc Sediment Characterization 2012	RP-12	RP-12	10/13/2011	117		Yes	No	No	No	No	432%	green
4.5	WST305	10/21/1997	21	J	Yes	No	No	No	LDW outfall sediment survey	LDW-SS2098-A	LDW-SS2098-A	3/4/2011	4.8	U	No	No	No	No	No	-77%	green
4.9	7	7/9/2002	5300	J	Yes	Yes	Yes	Yes	Boeing Developmental Center Sediment 2010-2015	S1	S1-091015	9/10/2015	270		Yes	Yes	No	Yes	Yes	-95%	blue
4.9			5300	J	Yes	Yes	Yes	Yes		S1	S4-091015	9/10/2015	530		Yes	Yes	No	Yes	Yes	-90%	blue
4.9			5300	J	Yes	Yes	Yes	Yes		S1	S1-090914	9/9/2014	1790		Yes	Yes	Yes	Yes	Yes	-66%	blue
4.9			5300	J	Yes	Yes	Yes	Yes		S1	S4-090914	9/9/2014	770		Yes	Yes	No	Yes	Yes	-85%	blue
4.9			5300	J	Yes	Yes	Yes	Yes		S1	S1-091613	9/16/2013	49		Yes	No	No	No	Yes	-99%	blue
4.9			5300	J	Yes	Yes	Yes	Yes		S1	S4-091613	9/16/2013	60		Yes	No	No	No	Yes	-99%	blue
4.9			5300	J	Yes	Yes	Yes	Yes		S1	S1-082812	8/28/2012	154		Yes	No	No	No	Yes	-97%	blue
4.9			5300	J	Yes	Yes	Yes	Yes		S1	S4-082812	8/28/2012	240		Yes	No	No	No	Yes	-95%	blue
4.9			5300	J	Yes	Yes	Yes	Yes		S1	S4-041111	11/4/2011	610		Yes	Yes	No	Yes	Yes	-88%	blue
4.9			5300	J	Yes	Yes	Yes	Yes		S1	S1-041111	11/4/2011	670		Yes	Yes	No	Yes	Yes	-87%	blue
4.9			5300	J	Yes	Yes	Yes	Yes		S1	S4-100510	10/5/2010	560		Yes	Yes	No	Yes	Yes	-89%	blue
4.9			5300	J	Yes	Yes	Yes	Yes		S1	S1-100510	10/5/2010	520		Yes	Yes	No	Yes	Yes	-90%	blue

Table 3a. Resampled Surface Sediment—Total PCBs

	FS Data								Post-FS New Data											Location Trend		
RM	Location Name	Sample Date	Total PCBs (µg/kg dw)	Qualifier	Detected?	Exceeds SCO?	Exceeds CSL?	Detected Above SCO?	Task Description - Resampling	Location Name	Sample Name	Sample Date	Total PCBs (µg/kg dw)	Qualifier	Detected?	Exceeds SCO?	Exceeds CSL?	Detected Above SCO?	Either Detected Above SCO?	Percent Change	Trend Code for Mapping
4.9	NFK507	2/10/2000	8440		Yes	Yes	Yes	Yes	Boeing Developmental Center Sediment 2010-2015	S2	S2-091015	9/10/2015	42		Yes	No	No	No	Yes	-100%	blue
4.9			8440		Yes	Yes	Yes	Yes		S2	S2-090914	9/9/2014	91		Yes	Yes	No	Yes	Yes	-99%	blue
4.9			8440		Yes	Yes	Yes	Yes		S2	S2-091613	9/16/2013	61		Yes	No	No	No	Yes	-99%	blue
4.9			8440		Yes	Yes	Yes	Yes		S2	S2-082812	8/28/2012	105		Yes	No	No	No	Yes	-99%	blue
4.9			8440		Yes	Yes	Yes	Yes		S2	S2-041111	11/4/2011	32	U	No	No	No	No	Yes	-100%	blue
4.9			8440		Yes	Yes	Yes	Yes		S2	S2-100510	10/5/2010	44		Yes	No	No	No	Yes	-99%	blue
4.9	NFK508	2/10/2000	4880		Yes	Yes	Yes	Yes	Boeing Developmental Center Sediment 2010-2015	S2	S2-091015	9/10/2015	42		Yes	No	No	No	Yes	-99%	blue
4.9			4880		Yes	Yes	Yes	Yes		S2	S2-090914	9/9/2014	91		Yes	Yes	No	Yes	Yes	-98%	blue
4.9			4880		Yes	Yes	Yes	Yes		S2	S2-091613	9/16/2013	61		Yes	No	No	No	Yes	-99%	blue
4.9			4880		Yes	Yes	Yes	Yes		S2	S2-082812	8/28/2012	105		Yes	No	No	No	Yes	-98%	blue
4.9			4880		Yes	Yes	Yes	Yes		S2	S2-041111	11/4/2011	32	U	No	No	No	No	Yes	-99%	blue
4.9			4880		Yes	Yes	Yes	Yes		S2	S2-100510	10/5/2010	44		Yes	No	No	No	Yes	-99%	blue
5	DR276	9/15/1998	32		Yes	No	No	No	LDW AOC3 in-water sediment sampling 2018	LDW18-SS-188	LDW18-SS-188	2/28/2018	18	U	No	No	No	No	No	-44%	green

Notes:

During or immediately after Boeing Plant 2 dredging (January 2013 to February 2015).

Immediately after Slip 4 dredging (October to November 2011)

Trend Code for Mapping: If neither sample has concentrations detected above the benthic SCO, code as "green" and do not evaluate trends. Blue = concentration decrease >50%. Gray = concentration change less than 50%. Red = concentration increase > 50%.

Font color in "Percent Change" column uses the above Trend Code criteria with the exception of assigning green to locations below the benthic SCO. (i.e., locations below the benthic SCO are colored by the concentration change instead of green.)

Resampled locations were identified where a new location was within 10 ft of an FS location.

Does not include Duw/Diag ENR and perimeter stations

Undetected data are reported at the reporting limit.

AOC = administrative order on consent
CSL = cleanup screening level (benthic: 65 mg/kg oc; 1,000 µg/kg dw)
dw = dry weight
EAA = early action area
FS = Feasibility Study
LDW = Lower Duwamish Waterway
PCB = polychlorinated biphenyl
RI/FS = Remedial Investigation and Feasibility Study
RM = river mile
SCO = sediment cleanup objective (benthic: 12 mg/kg oc or 130 µg/kg dw as defined in RI/FS)

Table 3b. Resampled Surface Sediment—cPAHs

	FS Data						Post-FS New Data								Location Trend		
RM	Location Name	Sample Date	cPAH (µg TEQ/kg dw)	Qualifier	Detected?	Detected Above RAL (1,000 µg/kg)	Task Description	Location Name - Resampling	Sample Name	Sample Date	cPAH (µg TEQ/kg dw)	Qualifier	Detected?	Detected Above RAL (1,000 µg/kg)	Either Detected Above RAL?	Percent Change	Trend Code for Mapping
0.1	LDW-SS306	10/3/2006	44	U	No	No	LDW outfall sediment survey	LDW-SS2233-U	LDW-SS2233-U	4/20/2011	27	J	Yes	No	No	-39%	green
0.6	DR010	9/14/1998	380		Yes	No	LDW AOC3 in-water sediment sampling 2018	LDW18-SS-170	LDW18-SS-170	3/1/2018	88.9	J	Yes	No	No	-77%	green
0.9	LDW-SS318	10/4/2006	280	J	Yes	No	Slip 1 Sediment Sampling May/June 2015	27	SL1-SS-SD-G027	6/2/2015	140		Yes	No	No	-50%	green
0.9	LDW-SS319	10/4/2006	560	J	Yes	No		24	SL1-SS-SD-G024	6/3/2015	210		Yes	No	No	-63%	green
1	B3b	8/17/2004	2200		Yes	Yes		46	SL1-SS-SD-G046	6/4/2015	820	J	Yes	No	Yes	-63%	blue
1	DR017	8/17/1998	1500		Yes	Yes		38	SL1-SS-SD-G038	6/4/2015	630	J	Yes	No	Yes	-58%	blue
1	DR018	9/2/1998	500		Yes	No		35	SL1-SS-SD-G035	6/3/2015	270		Yes	No	No	-46%	green
1	LDW-SS32	1/18/2005	340		Yes	No		36	SL1-SS-SD-G036	6/1/2015	640		Yes	No	No	88%	green
1	LDW-SS320	10/4/2006	630	J	Yes	No		30	SL1-SS-SD-G030	6/3/2015	270		Yes	No	No	-57%	green
1	LDW-SS321	10/4/2006	240		Yes	No		2	SL1-SS-SD-G002	6/2/2015	57	J	Yes	No	No	-76%	green
1	LDW-SS35	3/8/2005	3000		Yes	Yes		9	SL1-SS-SD-G009	6/4/2015	470		Yes	No	Yes	-84%	blue
1	LDW-SS37	1/18/2005	210		Yes	No		1	SL1-SS-SD-G001	6/2/2015	58		Yes	No	No	-72%	green
1.1	WQABRAN	6/3/1997	368	J	Yes	No	King County CSO Sediment Quality Characterization 2011	CSO-BR-5	L53963-42	8/29/2011	400		Yes	No	No	9%	green
1.4	LDW-SS56	1/24/2005	450		Yes	No	Glacier Northwest - Reichhold RI/FS	SED-SS-22	SED-SS-22-052312	5/23/2012	360		Yes	No	No	-20%	green
1.6	DR092	8/27/1998	160		Yes	No	LDW AOC3 in-water sediment sampling 2018	LDW18-SS-178	LDW18-SS-178	3/1/2018	409		Yes	No	No	156%	green
1.6			160		Yes	No		LDW18-SS-178	LDW18-SS-178-FD	3/1/2018	526		Yes	No	No	229%	green
1.9	DR155	8/13/1998	410		Yes	No		LDW18-SS-183	LDW18-SS-183	3/2/2018	158	J	Yes	No	No	-61%	green
1.9	LDW-SS69b	3/16/2005	580		Yes	No	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	3/24/2011	200	J	Yes	No	No	-66%	green
1.9	LDW-SS72	1/24/2005	500		Yes	No		LDW-SSPSF-D	LDW-SSPSF-D	3/7/2011	73	J	Yes	No	No	-85%	green
1.9	R5	10/15/1997	890		Yes	No		LDW-SS2122-D	LDW-SS2122-D	3/8/2011	580		Yes	No	No	-35%	green
2.8	DR179	8/24/1998	2500		Yes	Yes	Slip 4 EAA Removal Action Completion	WC-4	SD0028	1/30/2012	16	U	No	No	Yes	-99%	blue
			2500		Yes	Yes	Slip 4 Long-Term Monitoring Year 1	WC-4	SD0104	7/22/2013	67		Yes	No	Yes	-97%	blue
2.9	DR180	8/24/1998	300		Yes	No	Slip 4 EAA Removal Action Completion	BD-7	SD0008	8/24/2011	120		Yes	No	No	-60%	green
			300					BD-7	SD0047	2/1/2012	250		Yes	No	No	-17%	green
2.9	DR-181	8/10/2006	320		Yes	No		BD-2	SD0002	8/24/2011	73	J	Yes	No	No	-77%	green
			320					BD-2	SD0042	2/2/2012	280		Yes	No	No	-13%	green
2.9	EIT-066	8/10/2006	250		Yes	No	Boeing Plant 2 Post-construction surface sed monitoring Year 0	SD-PCM010	SD-PCM01015	3/11/2015	14	U	No	No	No	-94%	green
			250					SD-PCM010	SD-PCM01016	3/9/2016	35	J	Yes	No	No	-86%	green
3.7	R20	10/10/1997	170		Yes	No	LDW AOC3 in-water sediment sampling 2018	LDW18-SS-187	LDW18-SS-187	3/2/2018	30	J	Yes	No	No	-82%	green
3.7	T117-SE-46-G	12/9/2003	260		Yes	No	LDW outfall sediment survey	LDW-SSSP5-A	LDW-SSSP5-A	3/3/2011	43		Yes	No	No	-83%	green
3.9	DR258	8/25/1998	170		Yes	No	LDW AOC3 in-water sediment sampling 2018	LDW18-SS-186	LDW18-SS-186	2/28/2018	52.3		Yes	No	No	-69%	green

Table 3b. Resampled Surface Sediment—cPAHs

	FS Data						Post-FS New Data								Location Trend		
RM	Location Name	Sample Date	cPAH (µg TEQ/kg dw)	Qualifier	Detected?	Detected Above RAL (1,000 µg/kg)	Task Description	Location Name - Resampling	Sample Name	Sample Date	cPAH (µg TEQ/kg dw)	Qualifier	Detected?	Detected Above RAL (1,000 µg/kg)	Either Detected Above RAL?	Percent Change	Trend Code for Mapping
4.1	DR239	8/27/1998	240		Yes	No	Former Rhone Poulenc Sediment Characterization 2012	RP-12	RP-12	10/13/2011	190		Yes	No	No	-21%	green
5	DR276	9/15/1998	500		Yes	No	LDW AOC3 in-water sediment sampling 2018	LDW18-SS-188	LDW18-SS-188	2/28/2018	17.4	U	No	No	No	-97%	green

Notes:

Trend Code for Mapping: If neither sample has concentrations detected above the RAL, code as "green" and do not evaluate trends. Blue = concentration decrease >50%. Gray = concentration change less than 50%. Red = concentration increase > 50%.

Font color in "Percent Change" column uses the above Trend Code criteria with the exception of assigning green to locations below the RAL. (i.e., locations below the RAL are colored by the concentration change instead of green.)

Resampled locations were identified where a new location was within 10 ft of an FS location.

Does not include Duw/Diag ENR and perimeter stations.

Undetected data are reported at the reporting limit.

cPAH = carcingonic polycyclic aromatic hydrocarbons
dw = dry weight
EAA = early action area
FS = Feasibility Study
LDW = Lower Duwamish Waterway
RAL = remedial action level
RM = river mile
TEQ = toxicity equivalent

Table 3c. Resampled Surface Sediment—Arsenic

	FS Data							Post-FS New Data									Location Trend		
RM	Location Name	Sample Date	Arsenic (mg/kg)	Qualifier	Detected?	Exceeds SCO?	Detected Above SCO?	Task Description - Resampling	Location Name	Sample Name	Sample Date	Arsenic (mg/kg)	Qualifier	Detected?	Exceeds SCO?	Detected Above SCO?	Either Detected Above SCO?	Percent Change	Trend Code for Mapping
0.1	LDW-SS306	10/3/2006	5.1		Yes	No	No	LDW outfall sediment survey	LDW-SS2233-U	LDW-SS2233-U	4/20/2011	10		Yes	No	No	No	96%	green
0.6	DR010	9/14/1998	4.7		Yes	No	No	LDW AOC3 in-water sediment sampling 2018	LDW18-SS-170	LDW18-SS-170	3/1/2018	3.58		Yes	No	No	No	-24%	green
0.9	LDW-SS318	10/4/2006	8.8		Yes	No	No	Slip 1 Sediment Sampling May/June 2015	27	SL1-SS-SD-G027	6/2/2015	10.3		Yes	No	No	No	17%	green
0.9	LDW-SS319	10/4/2006	14.8		Yes	No	No		24	SL1-SS-SD-G024	6/3/2015	14.4		Yes	No	No	No	-3%	green
1	B3b	8/17/2004	725	J	Yes	Yes	Yes		46	SL1-SS-SD-G046	6/4/2015	102	J	Yes	Yes	Yes	Yes	-86%	blue
1	DR017	8/17/1998	20		Yes	No	No		38	SL1-SS-SD-G038	6/4/2015	23.9	J	Yes	No	No	No	20%	green
1	DR018	9/2/1998	17.4		Yes	No	No		35	SL1-SS-SD-G035	6/3/2015	17.3		Yes	No	No	No	-1%	green
1	LDW-SS32	1/18/2005	15.7		Yes	No	No		36	SL1-SS-SD-G036	6/1/2015	21.7	J	Yes	No	No	No	38%	green
1	LDW-SS320	10/4/2006	14.8		Yes	No	No		30	SL1-SS-SD-G030	6/3/2015	16.5		Yes	No	No	No	11%	green
1	LDW-SS321	10/4/2006	12.9		Yes	No	No		2	SL1-SS-SD-G002	6/2/2015	10.8		Yes	No	No	No	-16%	green
1	LDW-SS35	3/8/2005	12.6		Yes	No	No		9	SL1-SS-SD-G009	6/4/2015	13.2	J	Yes	No	No	No	5%	green
1	LDW-SS37	1/18/2005	13.6		Yes	No	No		1	SL1-SS-SD-G001	6/2/2015	10.5		Yes	No	No	No	-23%	green
1.1	WQABRAN	6/3/1997	17.7		Yes	No	No	King County CSO Sediment Quality Characterization 2011	CSO-BR-5	L53963-42	8/29/2011	13.3		Yes	No	No	No	-25%	green
1.4	LDW-SS56	1/24/2005	161		Yes	Yes	Yes	Glacier Northwest - Reichhold RI/FS	SED-SS-22	SED-SS-22-052312	5/23/2012	50.9		Yes	No	No	Yes	-68%	blue
1.6	DR092	8/27/1998	6		Yes	No	No	LDW AOC3 in-water sediment sampling 2018	LDW18-SS-178	LDW18-SS-178	3/1/2018	18.6		Yes	No	No	No	210%	green
1.6			6		Yes	No	No	LDW AOC3 in-water sediment sampling 2018	LDW18-SS-178	LDW18-SS-178-FD	3/1/2018	27.2		Yes	No	No	No	353%	green
1.9	DR155	8/13/1998	12.7		Yes	No	No	LDW AOC3 in-water sediment sampling 2018	LDW18-SS-183	LDW18-SS-183	3/2/2018	14.3		Yes	No	No	No	13%	green
1.9	LDW-SS69b	3/16/2005	16.9		Yes	No	No	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	3/24/2011	10	J	Yes	No	No	No	-41%	green
1.9	LDW-SS72	1/24/2005	15.5		Yes	No	No	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	3/7/2011	20		Yes	No	No	No	29%	green

Table 3c. Resampled Surface Sediment—Arsenic

	FS Data							Post-FS New Data									Location Trend		
RM	Location Name	Sample Date	Arsenic (mg/kg)	Qualifier	Detected?	Exceeds SCO?	Detected Above SCO?	Task Description - Resampling	Location Name	Sample Name	Sample Date	Arsenic (mg/kg)	Qualifier	Detected?	Exceeds SCO?	Detected Above SCO?	Either Detected Above SCO?	Percent Change	Trend Code for Mapping
1.9	R5	10/15/1997	13.3		Yes	No	No	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	3/8/2011	20		Yes	No	No	No	50%	green
2.2	B5a-2	9/24/2004	7.41	J	Yes	No	No	Industrial Container Services (EAA 2)	B5a2	ICS-B5a2-SE-091914	9/19/2014	8	U	No	No	No	No	8%	green
2.2	EAA2-SED-1	5/4/2007	48.7		Yes	No	No		SED1	ICS-SED1-SE-091914	9/19/2014	30	U	No	No	No	No	-38%	green
2.2	EAA2-SED-2	5/4/2007	20.1		Yes	No	No		SED2	ICS-SED2-SE-091914	9/19/2014	30		Yes	No	No	No	49%	green
2.2	EAA2-SED-4	5/7/2007	3		Yes	No	No		SED4	ICS-SED4-SE-091914	9/19/2014	6	U	No	No	No	No	100%	green
2.2	LDW-SS84	1/19/2005	12.3		Yes	No	No		LDWSS84	ICS-LDWSS84-SE-091914	9/19/2014	10	U	No	No	No	No	-19%	green
2.8	DR179	8/24/1998	14.8		Yes	No	No	City of Seattle Slip 4 Long Term Monitoring (Year 5)	WC-4	SL4-SD0125	7/24/2017	2.83	J	Yes	No	No	No	-81%	green
2.8		8/24/1998	14.8		Yes	No	No	Slip 4 Long-Term Monitoring Year 1	WC-4	SD0104	7/22/2013	6	U	No	No	No	No	-59%	green
2.8		8/24/1998	14.8		Yes	No	No	Slip 4 EAA Removal Action Completion	WC-4	SD0028	1/30/2012	6	U	No	No	No	No	-59%	green
2.9	DR180	8/24/1998	13.5		Yes	No	No		BD-7	SD0047	2/1/2012	20		Yes	No	No	No	48%	green
2.9		8/24/1998	13.5		Yes	No	No		BD-7	SD0008	8/24/2011	20		Yes	No	No	No	48%	green
2.9	DR-181	8/10/2006	19.6		Yes	No	No		BD-2	SD0002	8/24/2011	20		Yes	No	No	No	2%	green
2.9			14.5	J	Yes	No	No	Boeing Plant 2 Post-construction surface sed monitoring Year 1	SD-PCM010	SD-PCM01016	3/9/2016	5.7		Yes	No	No	No	-61%	green
2.9			14.5	J	Yes	No	No	Boeing Plant 2 Post-construction surface sed monitoring Year 0	SD-PCM010	SD-PCM01015	3/11/2015	1.9		Yes	No	No	No	-87%	green
2.9			19.6		Yes	No	No	Slip 4 EAA Removal Action Completion	BD-2	SD0042	2/2/2012	20		Yes	No	No	No	2%	green

Table 3c. Resampled Surface Sediment—Arsenic

	FS Data							Post-FS New Data										Location Trend		
RM	Location Name	Sample Date	Arsenic (mg/kg)	Qualifier	Detected?	Exceeds SCO?	Detected Above SCO?	Task Description - Resampling	Location Name	Sample Name	Sample Date	Arsenic (mg/kg)	Qualifier	Detected?	Exceeds SCO?	Detected Above SCO?	Either Detected Above SCO?	Percent Change	Trend Code for Mapping
3	LDW-SS99	1/19/2005	6.8		Yes	No	No	Boeing Plant 2 Perimeter monitoring	SD-PER206	SD-PER206-0315	3/18/2015	6.4		Yes	No	No	No	-6%	green
3			6.8		Yes	No	No		SD-PER206	SD-PER206-0914	9/17/2014	6.9		Yes	No	No	No	1%	green
3			6.8		Yes	No	No		SD-PER206	SD-PER206-0314	3/14/2014	7.1		Yes	No	No	No	4%	green
3			6.8		Yes	No	No		SD-PER206	SD-PER206-1213	12/12/2013	3.7		Yes	No	No	No	-46%	green
3			6.8		Yes	No	No		SD-PER206	SD-PER206-0313	3/11/2013	5.3		Yes	No	No	No	-22%	green
3			6.8		Yes	No	No		SD-PER206	SD-PER206-1212	12/5/2012	9.6		Yes	No	No	No	41%	green
3.5	SD-DUW82	4/3/1996	10	U	No	No	No		SD-PER306	SD-PER306-0315	2/27/2015	8.7		Yes	No	No	No	-13%	green
3.5			10	U	No	No	No		SD-PER306	SD-PER306-0914	9/15/2014	9.2		Yes	No	No	No	-8%	green
3.5			10	U	No	No	No		SD-PER306	SD-PER306-0714	7/14/2014	9	UJ	No	No	No	No	-10%	green
3.5			10	U	No	No	No		SD-PER306	SD-PER306-1213	12/19/2013	8.6		Yes	No	No	No	-14%	green
3.5			10	U	No	No	No		SD-PER306	SD-PER306-1212	12/10/2012	10.9		Yes	No	No	No	9%	green
3.7	R20	10/10/1997	11.9		Yes	No	No	LDW AOC3 in-water sediment sampling 2018	LDW18-SS-187	LDW18-SS-187	3/2/2018	18.2		Yes	No	No	No	53%	green
3.7	T117-SE-46-G	12/9/2003	7	U	No	No	No	LDW outfall sediment survey	LDW-SSSP5-A	LDW-SSSP5-A	3/3/2011	11		Yes	No	No	No	57%	green
3.9	DR258	8/25/1998	11.5		Yes	No	No	LDW AOC3 in-water sediment sampling 2018	LDW18-SS-186	LDW18-SS-186	2/28/2018	10.3		Yes	No	No	No	-10%	green
3.9	R29	10/9/1997	8.8		Yes	No	No	Boeing Plant 2 Perimeter monitoring - End of Season 2014 (Event 4)	SD-PER404	SD-PER404-0914	9/19/2014	7.9		Yes	No	No	No	-10%	green
3.9	R29	10/9/1997	8.8		Yes	No	No		SD-PER404	SD-PER404-0714	7/16/2014	7.1		Yes	No	No	No	-19%	green
3.9	R29	10/9/1997	8.8		Yes	No	No		SD-PER404	SD-PER404-0314	3/24/2014	7		Yes	No	No	No	-20%	green
4.1	DR239	8/27/1998	8.8		Yes	No	No	Former Rhone Poulenc Sediment Characterization 2012	RP-12	RP-12	10/13/2011	9.4		Yes	No	No	No	7%	green

Table 3c. Resampled Surface Sediment—Arsenic

	FS Data							Post-FS New Data									Location Trend		
RM	Location Name	Sample Date	Arsenic (mg/kg)	Qualifier	Detected?	Exceeds SCO?	Detected Above SCO?	Task Description - Resampling	Location Name	Sample Name	Sample Date	Arsenic (mg/kg)	Qualifier	Detected?	Exceeds SCO?	Detected Above SCO?	Either Detected Above SCO?	Percent Change	Trend Code for Mapping
4.2	05-intsed-1	7/1/1996	11.1		Yes	No	No	Former Rhone Poulenc Sediment Characterization 2012	RP-27	RP-27	2/13/2012	9		Yes	No	No	No	-19%	green
5	DR276	9/15/1998	9.5		Yes	No	No	LDW AOC3 in-water sediment sampling 2018	LDW18-SS-188	LDW18-SS-188	2/28/2018	3.89		Yes	No	No	No	-59%	green

Notes:

Trend Code for Mapping: If neither sample has concentrations detected above the benthic SCO, code as "green" and do not evaluate trends. Blue = concentration decrease >50%. Gray = concentration change less than 50%. Red = concentration increase > 50%.
Font color in "Percent Change" column uses the above Trend Code criteria with the exception of assigning green to locations below the benthic SCO. (i.e., locations below the benthic SCO are colored by the concentration change instead of green.)
Resampled locations were identified where a new location was within 10 ft of an FS location.
Does not include Duw/Diag ENR and perimeter stations
Undetected data are reported at the reporting limit.

AOC = administrative order on consent
dw = dry weight
EAA = early action area
FS = Feasibility Study
LDW = Lower Duwamish Waterway
RI/FS = Remedial Investigation and Feasibility Study
RM = river mile
SCO = sediment cleanup objective (benthic: 57 mg/kg dw)

Table 3d. Resampled Surface Sediment—BEHP

	FS Data								Post-FS New Data										Location Trend		
RM	Location Name	Sample Date	BEHP (µg/kg dw)	Qualifier	Detected?	Exceeds SCO?	Exceeds CSL?	Detected Above SCO?	Task Description - Resampling	Location Name	Sample Name	Sample Date	BEHP (µg/kg dw)	Qualifier	Detected?	Exceeds SCO?	Exceeds CSL?	Detected Above SCO?	Either Detected Above SCO?	Percent Change	Trend Code for Mapping
0.1	LDW-SS306	10/3/2006	61	U	No	No	No	no	LDW outfall sediment survey	LDW-SS2233-U	LDW-SS2233-U	4/20/2011	16	J	Yes	No	No	No	No	-74%	green
0.6	DR010	9/14/1998	760		Yes	Yes	No	yes	LDW AOC3 in-water sediment sampling 2018	LDW18-SS-170	LDW18-SS-170	3/1/2018	86.1		Yes	No	No	No	Yes	-89%	blue
1.1	WQABRAN	6/3/1997	637		Yes	No	No	no	King County CSO Sediment Quality Characterization 2011	CSO-BR-5	L53963-42	8/29/2011	659		Yes	No	No	No	No	3%	green
1.4	LDW-SS56	1/24/2005	210		Yes	No	No	no	Glacier Northwest - Reichhold RI/FS	SED-SS-22	SED-SS-22-052312	5/23/2012	41		Yes	No	No	No	No	-80%	green
1.6	DR092	8/27/1998	110		Yes	No	No	no	LDW AOC3 in-water sediment sampling 2018	LDW18-SS-178	LDW18-SS-178	3/1/2018	339		Yes	No	No	No	No	208%	green
1.6			110		Yes	No	No	no		LDW18-SS-178	LDW18-SS-178-FD	3/1/2018	347		Yes	No	No	No	No	215%	green
1.9	DR155	8/13/1998	2500		Yes	Yes	Yes	yes		LDW18-SS-183	LDW18-SS-183	3/2/2018	203		Yes	No	No	No	Yes	-92%	blue
1.9	LDW-SS69b	3/16/2005	440		Yes	No	No	no	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	3/24/2011	170		Yes	No	No	No	No	-61%	green
1.9	LDW-SS72	1/24/2005	400		Yes	No	No	no		LDW-SSPSF-D	LDW-SSPSF-D	3/7/2011	63		Yes	No	No	No	No	-84%	green
1.9	R5	10/15/1997	440		Yes	No	No	no		LDW-SS2122-D	LDW-SS2122-D	3/8/2011	570		Yes	No	No	No	No	30%	green
2.8	DR179	8/24/1998	2800		Yes	Yes	Yes	yes	City of Seattle Slip 4 Long Term Monitoring (Year 5)	WC-4	SL4-SD0125	7/24/2017	471		Yes	Yes	No	Yes	Yes	-83%	blue
2.8			2800		Yes	Yes	Yes	yes	Slip 4 Long-Term Monitoring Year 1	WC-4	SD0104	7/22/2013	99		Yes	No	No	No	Yes	-96%	blue
2.8			2800		Yes	Yes	Yes	yes	Slip 4 EAA Removal Action Completion	WC-4	SD0028	1/30/2012	32	U	No	No	No	No	Yes	-99%	blue
2.9	DR180	8/24/1998	500		Yes	No	No	no		BD-7	SD0047	2/1/2012	400		Yes	No	No	No	No	-20%	green
2.9			500		Yes	No	No	no		BD-7	SD0008	8/24/2011	280		Yes	No	No	No	No	-44%	green
2.9	DR-181	8/10/2006	584		Yes	No	No	no		BD-2	SD0042	2/2/2012	400		Yes	No	No	No	No	-32%	green
2.9			584		Yes	No	No	no		BD-2	SD0002	8/24/2011	140	U	No	No	No	No	No	-76%	green
2.9	EIT-066	8/10/2006	439	U	No	No	No	no	Boeing Plant 2 Post-construction surface sed	SD-PCM010	SD-PCM01016	3/9/2016	85		Yes	No	No	No	No	-81%	green
2.9			439	U	No	No	No	no		SD-PCM010	SD-PCM01015	3/11/2015	48	U	No	No	No	No	No	-89%	green
3.7	R20	10/10/1997	200		Yes	No	No	no	LDW AOC3 in-water sediment sampling 2018	LDW18-SS-187	LDW18-SS-187	3/2/2018	37.5	J	Yes	No	No	No	No	-81%	green
3.7	T117-SE-46-G	12/9/2003	76		Yes	No	No	no	LDW outfall sediment survey	LDW-SSSP5-A	LDW-SSSP5-A	3/3/2011	150	U	No	No	No	No	No	97%	green
3.9	DR258	8/25/1998	390		Yes	No	No	no	LDW AOC3 in-water sediment sampling 2018	LDW18-SS-186	LDW18-SS-186	2/28/2018	98.3		Yes	No	No	No	No	-75%	green
4.1	DR239	8/27/1998	100		Yes	No	No	no	Former Rhone Poulenc Sediment Characterization 2012	RP-12	RP-12	10/13/2011	78		Yes	No	No	No	No	-22%	green

Table 3d. Resampled Surface Sediment—BEHP

	FS Data								Post-FS New Data										Location Trend		
RM	Location Name	Sample Date	BEHP (µg/kg dw)	Qualifier	Detected?	Exceeds SCO?	Exceeds CSL?	Detected Above SCO?	Task Description - Resampling	Location Name	Sample Name	Sample Date	BEHP (µg/kg dw)	Qualifier	Detected?	Exceeds SCO?	Exceeds CSL?	Detected Above SCO?	Either Detected Above SCO?	Percent Change	Trend Code for Mapping
5	DR276	9/15/1998	340		Yes	No	No	no	LDW AOC3 in-water sediment sampling 2018	LDW18-SS-188	LDW18-SS-188	2/28/2018	48	U	No	No	No	No	No	-86%	green

Notes:

Trend Code for Mapping: If neither sample has concentrations detected above the benthic SCO, code as "green" and do not evaluate trends. Blue = concentration decrease >50%. Gray = concentration change less than 50%. Red = concentration increase > 50%.
Font color in "Percent Change" column uses the above Trend Code criteria with the exception of assigning green to locations below the benthic SCO. (i.e., locations below the benthic SCO are colored by the concentration change instead of green.)
Resampled locations were identified where a new location was within 10 ft of an FS location.
Does not include Duw/Diag ENR and perimeter stations.
Undetected data are reported at the reporting limit.

AOC = administrative order on consent
BEHP = bis(2-ethylhexyl)phthalate
CSL = cleanup screening level (benthic: 78 mg/kg oc; 1,900 µg/kg dw)
dw = dry weight
EAA = early action area
FS = Feasibility Study
LDW = Lower Duwamish Waterway
RI/FS = Remedial Investigation and Feasibility Study
RM = river mile
SCO = sediment cleanup objective (benthic: 47 mg/kg oc or 1,300 µg/kg dw as defined in RI/FS)

Table 4a. Resampled Surface Sediment at Duwamish/Diagonal EAA Perimeter Stations—Total PCBs

	2003 Data (Pre-Construction)								New Data									Location Trend		
RM	Location Name	Sample Date	Total PCBs (µg/kg dw)	Qualifier	Detected?	Exceeds SCO?	Exceeds CSL?	Detected Above SCO?	Task Description	Location Name	Sample Date	Total PCBs (µg/kg dw)	Qualifier	Detected?	Exceeds SCO?	Exceeds CSL?	Detected Above SCO?	Either Detected Above SCO?	Percent Change	Trend Code for Mapping
0.4	DUD_10C	21-Oct-03	373		Yes	Yes	No	Yes	Duwamish Diagonal 2012	DUD_10C	3/28/2012	192.9		Yes	Yes	No	Yes	Yes	-48%	gray
0.4	DUD_10C	21-Oct-03	373		Yes	Yes	No	Yes	Duwamish Diagonal 2011	DUD_10C	3/28/2011	121.4		Yes	No	No	No	Yes	-67%	blue
0.4	DUD_10C	21-Oct-03	373		Yes	Yes	No	Yes	Duwamish Diagonal 2010	DUD_10C	3/29/2010	146.5		Yes	Yes	No	Yes	Yes	-61%	blue
0.4	DUD_10C	21-Oct-03	373		Yes	Yes	No	Yes	DuwDiagonalApril2009	DUD_10C	4/29/2009	141.8		Yes	Yes	No	Yes	Yes	-62%	blue
0.4	DUD_10C	21-Oct-03	373		Yes	Yes	No	Yes	DuwDiagonalMarch2008	DUD_10C	3/24/2008	159.4		Yes	Yes	No	Yes	Yes	-57%	blue
0.4	DUD_10C	21-Oct-03	373		Yes	Yes	No	Yes	DuwDiagonal April 2007	DUD_10C	4/2/2007	133.5	J	Yes	No	No	No	Yes	-64%	blue
0.4	DUD_10C	21-Oct-03	373		Yes	Yes	No	Yes	DuwDiagMarch2006	DUD_10C	3/8/2006	319		Yes	Yes	No	Yes	Yes	-14%	gray
0.4	DUD_10C	21-Oct-03	373		Yes	Yes	No	Yes	DuwDiagJan2005	DUD_10C	2/1/2005	328	J	Yes	Yes	No	Yes	Yes	-12%	gray
0.4	DUD_10C	21-Oct-03	373		Yes	Yes	No	Yes	DuwDiagonal-March2004	DUD_10C	3/30/2004	665	J	Yes	Yes	No	Yes	Yes	78%	red
0.4	DUD_11C	21-Oct-03	378		Yes	Yes	No	Yes	Duwamish Diagonal 2012	DUD_11C	3/28/2012	88.4		Yes	No	No	No	Yes	-77%	blue
0.4	DUD_11C	21-Oct-03	378		Yes	Yes	No	Yes	Duwamish Diagonal 2011	DUD_11C	3/28/2011	105.4	J	Yes	No	No	No	Yes	-72%	blue
0.4	DUD_11C	21-Oct-03	378		Yes	Yes	No	Yes	Duwamish Diagonal 2010	DUD_11C	3/30/2010	54.5		Yes	No	No	No	Yes	-86%	blue
0.4	DUD_11C	21-Oct-03	378		Yes	Yes	No	Yes	DuwDiagonalApril2009	DUD_11C	4/29/2009	66.9		Yes	No	No	No	Yes	-82%	blue
0.4	DUD_11C	21-Oct-03	378		Yes	Yes	No	Yes	DuwDiagonalMarch2008	DUD_11C	3/25/2008	59.7		Yes	No	No	No	Yes	-84%	blue
0.4	DUD_11C	21-Oct-03	378		Yes	Yes	No	Yes	DuwDiagonal April 2007	DUD_11C	4/2/2007	110	J	Yes	No	No	No	Yes	-71%	blue
0.4	DUD_11C	21-Oct-03	378		Yes	Yes	No	Yes	DuwDiagMarch2006	DUD_11C	3/9/2006	40.2		Yes	No	No	No	Yes	-89%	blue
0.4	DUD_11C	21-Oct-03	378		Yes	Yes	No	Yes	DuwDiagJan2005	DUD_11C	2/1/2005	18.8	J	Yes	No	No	No	Yes	-95%	blue
0.4	DUD_11C	21-Oct-03	378		Yes	Yes	No	Yes	DuwDiagonal-March2004	DUD_11C	3/30/2004	12	J	Yes	No	No	No	Yes	-97%	blue
0.4	DUD_12C	21-Oct-03	263		Yes	Yes	No	Yes	Duwamish Diagonal 2012	DUD_12C	3/28/2012	105.7		Yes	No	No	No	Yes	-60%	blue
0.4	DUD_12C	21-Oct-03	263		Yes	Yes	No	Yes	Duwamish Diagonal 2011	DUD_12C	3/29/2011	176.9		Yes	No	No	No	Yes	-33%	gray
0.4	DUD_12C	21-Oct-03	263		Yes	Yes	No	Yes	Duwamish Diagonal 2010	DUD_12C	3/30/2010	181.8		Yes	Yes	No	Yes	Yes	-31%	gray
0.4	DUD_12C	21-Oct-03	263		Yes	Yes	No	Yes	DuwDiagonalApril2009	DUD_12C	4/29/2009	240		Yes	Yes	No	Yes	Yes	-9%	gray
0.4	DUD_12C	21-Oct-03	263		Yes	Yes	No	Yes	DuwDiagonalMarch2008	DUD_12C	3/25/2008	245.8		Yes	Yes	No	Yes	Yes	-7%	gray
0.4	DUD_12C	21-Oct-03	263		Yes	Yes	No	Yes	DuwDiagonal April 2007	DUD_12C	4/2/2007	309	J	Yes	Yes	No	Yes	Yes	17%	gray
0.4	DUD_12C	21-Oct-03	263		Yes	Yes	No	Yes	DuwDiagMarch2006	DUD_12C	3/9/2006	383		Yes	Yes	No	Yes	Yes	46%	gray
0.4	DUD_12C	21-Oct-03	263		Yes	Yes	No	Yes	DuwDiagJan2005	DUD_12C	2/2/2005	334	J	Yes	Yes	No	Yes	Yes	27%	gray
0.4	DUD_12C	21-Oct-03	263		Yes	Yes	No	Yes	DuwDiagonal-March2004	DUD_12C	3/30/2004	644	J	Yes	Yes	Yes	Yes	Yes	145%	red

Table 4a. Resampled Surface Sediment at Duwamish/Diagonal EAA Perimeter Stations—Total PCBs

	2003 Data (Pre-Construction)								New Data									Location Trend		
RM	Location Name	Sample Date	Total PCBs (µg/kg dw)	Qualifier	Detected?	Exceeds SCO?	Exceeds CSL?	Detected Above SCO?	Task Description	Location Name	Sample Date	Total PCBs (µg/kg dw)	Qualifier	Detected?	Exceeds SCO?	Exceeds CSL?	Detected Above SCO?	Either Detected Above SCO?	Percent Change	Trend Code for Mapping
0.5	DUD_1C	20-Oct-03	621		Yes	Yes	No	Yes	Duwamish Diagonal 2012	DUD_1C	4/4/2012	146.6		Yes	No	No	No	Yes	-76%	blue
0.5	DUD_1C	20-Oct-03	621		Yes	Yes	No	Yes	Duwamish Diagonal 2011	DUD_1C	3/28/2011	180		Yes	No	No	No	Yes	-71%	blue
0.5	DUD_1C	20-Oct-03	621		Yes	Yes	No	Yes	Duwamish Diagonal 2010	DUD_1C	3/29/2010	62.8		Yes	No	No	No	Yes	-90%	blue
0.5	DUD_1C	20-Oct-03	621		Yes	Yes	No	Yes	DuwDiagonalApril2009	DUD_1C	4/27/2009	94.9		Yes	No	No	No	Yes	-85%	blue
0.5	DUD_1C	20-Oct-03	621		Yes	Yes	No	Yes	DuwDiagonalMarch2008	DUD_1C	3/24/2008	263		Yes	No	No	No	Yes	-58%	blue
0.5	DUD_1C	20-Oct-03	621		Yes	Yes	No	Yes	DuwDiagonal April 2007	DUD_1C	4/2/2007	146.8	J	Yes	No	No	No	Yes	-76%	blue
0.5	DUD_1C	20-Oct-03	621		Yes	Yes	No	Yes	DuwDiagMarch2006	DUD_1C	3/8/2006	605		Yes	Yes	No	Yes	Yes	-3%	gray
0.5	DUD_1C	20-Oct-03	621		Yes	Yes	No	Yes	DuwDiagJan2005	DUD_1C	2/1/2005	195.5	J	Yes	Yes	No	Yes	Yes	-69%	blue
0.5	DUD_1C	20-Oct-03	621		Yes	Yes	No	Yes	DuwDiagonal-March2004	DUD_1C	3/29/2004	241	J	Yes	Yes	No	Yes	Yes	-61%	blue
0.6	DUD_2C	20-Oct-03	382		Yes	Yes	No	Yes	Duwamish Diagonal 2011	DUD_2C	3/28/2011	183		Yes	No	No	No	Yes	-52%	blue
0.6	DUD_2C	20-Oct-03	382		Yes	Yes	No	Yes	Duwamish Diagonal 2010	DUD_2C	3/29/2010	72.6		Yes	No	No	No	Yes	-81%	blue
0.6	DUD_2C	20-Oct-03	382		Yes	Yes	No	Yes	DuwDiagonalApril2009	DUD_2C	4/27/2009	92.9		Yes	No	No	No	Yes	-76%	blue
0.6	DUD_2C	20-Oct-03	382		Yes	Yes	No	Yes	DuwDiagonalMarch2008	DUD_2C	3/24/2008	141.5		Yes	No	No	No	Yes	-63%	blue
0.6	DUD_2C	20-Oct-03	382		Yes	Yes	No	Yes	DuwDiagonal April 2007	DUD_2C	4/2/2007	157.6	J	Yes	No	No	No	Yes	-59%	blue
0.6	DUD_2C	20-Oct-03	382		Yes	Yes	No	Yes	DuwDiagMarch2006	DUD_2C	3/8/2006	274		Yes	Yes	No	Yes	Yes	-28%	gray
0.6	DUD_2C	20-Oct-03	382		Yes	Yes	No	Yes	DuwDiagJan2005	DUD_2C	1/31/2005	340	J	Yes	Yes	No	Yes	Yes	-11%	gray
0.6	DUD_2C	20-Oct-03	382		Yes	Yes	No	Yes	DuwDiagonal-March2004	DUD_2C	3/29/2004	368	J	Yes	Yes	No	Yes	Yes	-4%	gray
0.5	DUD_8C	21-Oct-03	4610		Yes	Yes	Yes	Yes	Duwamish Diagonal 2012	DUD_8C	3/28/2012	733		Yes	Yes	No	Yes	Yes	-84%	blue
0.5	DUD_8C	21-Oct-03	4610		Yes	Yes	Yes	Yes	Duwamish Diagonal 2011	DUD_8C	3/28/2011	1017		Yes	Yes	Yes	Yes	Yes	-78%	blue
0.5	DUD_8C	21-Oct-03	4610		Yes	Yes	Yes	Yes	Duwamish Diagonal 2010	DUD_8C	3/29/2010	692		Yes	Yes	No	Yes	Yes	-85%	blue
0.5	DUD_8C	21-Oct-03	4610		Yes	Yes	Yes	Yes	DuwDiagonalApril2009	DUD_8C	4/28/2009	2970		Yes	Yes	Yes	Yes	Yes	-36%	gray
0.5	DUD_8C	21-Oct-03	4610		Yes	Yes	Yes	Yes	DuwDiagonalMarch2008	DUD_8C	3/24/2008	290		Yes	Yes	No	Yes	Yes	-94%	blue
0.5	DUD_8C	21-Oct-03	4610		Yes	Yes	Yes	Yes	DuwDiagonal April 2007	DUD_8C	4/2/2007	435	J	Yes	Yes	No	Yes	Yes	-91%	blue
0.5	DUD_8C	21-Oct-03	4610		Yes	Yes	Yes	Yes	DuwDiagMarch2006	DUD_8C	3/8/2006	316		Yes	Yes	No	Yes	Yes	-93%	blue
0.5	DUD_8C	21-Oct-03	4610		Yes	Yes	Yes	Yes	DuwDiagJan2005	DUD_8C	2/1/2005	774	J	Yes	Yes	Yes	Yes	Yes	-83%	blue
0.5	DUD_8C	21-Oct-03	4610		Yes	Yes	Yes	Yes	DuwDiagonal-March2004	DUD_8C	3/30/2004	1902	J	Yes	Yes	Yes	Yes	Yes	-59%	blue

Table 4a. Resampled Surface Sediment at Duwamish/Diagonal EAA Perimeter Stations—Total PCBs

	2003 Data (Pre-Construction)								New Data									Location Trend		
RM	Location Name	Sample Date	Total PCBs (µg/kg dw)	Qualifier	Detected?	Exceeds SCO?	Exceeds CSL?	Detected Above SCO?	Task Description	Location Name	Sample Date	Total PCBs (µg/kg dw)	Qualifier	Detected?	Exceeds SCO?	Exceeds CSL?	Detected Above SCO?	Either Detected Above SCO?	Percent Change	Trend Code for Mapping
0.4	DUD_9C	21-Oct-03	102.9	J	Yes	Yes	No	Yes	Duwamish Diagonal 2012	DUD_9C	3/28/2012	518		Yes	Yes	Yes	Yes	Yes	403%	red
0.4	DUD_9C	21-Oct-03	102.9	J	Yes	Yes	No	Yes	Duwamish Diagonal 2011	DUD_9C	3/28/2011	248		Yes	Yes	No	Yes	Yes	141%	red
0.4	DUD_9C	21-Oct-03	102.9	J	Yes	Yes	No	Yes	Duwamish Diagonal 2010	DUD_9C	3/29/2010	64.1		Yes	No	No	No	Yes	-38%	gray
0.4	DUD_9C	21-Oct-03	102.9	J	Yes	Yes	No	Yes	DuwDiagonalApril2009	DUD_9C	4/29/2009	166.7		Yes	Yes	No	Yes	Yes	62%	red
0.4	DUD_9C	21-Oct-03	102.9	J	Yes	Yes	No	Yes	DuwDiagonalMarch2008	DUD_9C	3/24/2008	282		Yes	Yes	No	Yes	Yes	174%	red
0.4	DUD_9C	21-Oct-03	102.9	J	Yes	Yes	No	Yes	DuwDiagonal April 2007	DUD_9C	4/2/2007	311	J	Yes	Yes	No	Yes	Yes	202%	red
0.4	DUD_9C	21-Oct-03	102.9	J	Yes	Yes	No	Yes	DuwDiagMarch2006	DUD_9C	3/8/2006	269		Yes	Yes	No	Yes	Yes	161%	red
0.4	DUD_9C	21-Oct-03	102.9	J	Yes	Yes	No	Yes	DuwDiagJan2005	DUD_9C	1/31/2005	945	J	Yes	Yes	Yes	Yes	Yes	818%	red
0.4	DUD_9C	21-Oct-03	102.9	J	Yes	Yes	No	Yes	DuwDiagonal-March2004	DUD_9C	3/30/2004	734	J	Yes	Yes	Yes	Yes	Yes	613%	red

Notes:

Trend Code for Mapping: If neither sample has concentrations detected above the benthic SCO, code as "green" and do not evaluate trends. Blue = concentration decrease >50%. Gray = concentration change less than 50%. Red = concentration increase > 50%.

Font color in "Percent Change" column uses the above Trend Code criteria.

CSL = cleanup screening level (benthic: 65 mg/kg oc or 1,000 µg/kg dw as defined in RI/FS)

dw = dry weight

EAA = early action area

PCB = polychlorinated biphenyl

RM = river mile

SCO = sediment cleanup objective (benthic - 12 mg/kg oc or 130 µg/kg dw as defined in RI/FS)

Table 4b. Resampled Surface Sediment at Duwamish/Diagonal EAA Perimeter Stations—cPAHs

	2003 Data (Pre-Construction)						New Data							Location Trend		
RM	Location Name	Sample Date	cPAH (µg TEQ/kg dw)	Qualifier	Detected?	Detected Above RAL (1,000 µg/kg)?	Task Description	Location Name	Sample Date	cPAH (µg TEQ/kg dw)	Qualifier	Detected?	Detected Above RAL (1,000 µg/kg)?	Either Detected Above RAL?	Percent Change	Trend Code for Mapping
0.4	DUD_10C	21-Oct-03	337	J	Yes	No	Duwamish Diagonal 2012	DUD_10C	3/28/2012	220		Yes	No	No	-35%	green
0.4	DUD_10C	21-Oct-03	337	J	Yes	No	Duwamish Diagonal 2011	DUD_10C	3/28/2011	260		Yes	No	No	-23%	green
0.4	DUD_10C	21-Oct-03	337	J	Yes	No	Duwamish Diagonal 2010	DUD_10C	3/29/2010	110		Yes	No	No	-67%	green
0.4	DUD_10C	21-Oct-03	337	J	Yes	No	DuwDiagonal April2009	DUD_10C	4/29/2009	120		Yes	No	No	-64%	green
0.4	DUD_10C	21-Oct-03	337	J	Yes	No	DuwDiagonal March2008	DUD_10C	3/24/2008	160		Yes	No	No	-53%	green
0.4	DUD_10C	21-Oct-03	337	J	Yes	No	DuwDiag March2006	DUD_10C	3/8/2006	271		Yes	No	No	-20%	green
0.4	DUD_10C	21-Oct-03	337	J	Yes	No	DuwDiag Jan2005	DUD_10C	2/1/2005	249		Yes	No	No	-26%	green
0.4	DUD_10C	21-Oct-03	337	J	Yes	No	DuwDiagonal March2004	DUD_10C	3/30/2004	264	J	Yes	No	No	-22%	green
0.4	DUD_11C	21-Oct-03	558	J	Yes	No	Duwamish Diagonal 2012	DUD_11C	3/28/2012	250		Yes	No	No	-55%	green
0.4	DUD_11C	21-Oct-03	558	J	Yes	No	Duwamish Diagonal 2011	DUD_11C	3/28/2011	240		Yes	No	No	-57%	green
0.4	DUD_11C	21-Oct-03	558	J	Yes	No	Duwamish Diagonal 2010	DUD_11C	3/30/2010	120		Yes	No	No	-78%	green
0.4	DUD_11C	21-Oct-03	558	J	Yes	No	DuwDiagonal April2009	DUD_11C	4/29/2009	84		Yes	No	No	-85%	green
0.4	DUD_11C	21-Oct-03	558	J	Yes	No	DuwDiagonal March2008	DUD_11C	3/25/2008	140		Yes	No	No	-75%	green
0.4	DUD_11C	21-Oct-03	558	J	Yes	No	DuwDiag March2006	DUD_11C	3/9/2006	144		Yes	No	No	-74%	green
0.4	DUD_11C	21-Oct-03	558	J	Yes	No	DuwDiag Jan2005	DUD_11C	2/1/2005	30.6		Yes	No	No	-95%	green
0.4	DUD_11C	21-Oct-03	558	J	Yes	No	DuwDiagonal March2004	DUD_11C	3/30/2004	48.4	J	Yes	No	No	-91%	green
0.4	DUD_12C	21-Oct-03	478	J	Yes	No	Duwamish Diagonal 2012	DUD_12C	3/28/2012	220		Yes	No	No	-54%	green
0.4	DUD_12C	21-Oct-03	478	J	Yes	No	Duwamish Diagonal 2011	DUD_12C	3/29/2011	200		Yes	No	No	-58%	green
0.4	DUD_12C	21-Oct-03	478	J	Yes	No	Duwamish Diagonal 2010	DUD_12C	3/30/2010	150		Yes	No	No	-69%	green
0.4	DUD_12C	21-Oct-03	478	J	Yes	No	DuwDiagonal April2009	DUD_12C	4/29/2009	65		Yes	No	No	-86%	green
0.4	DUD_12C	21-Oct-03	478	J	Yes	No	DuwDiagonal March2008	DUD_12C	3/25/2008	290		Yes	No	No	-39%	green
0.4	DUD_12C	21-Oct-03	478	J	Yes	No	DuwDiag March2006	DUD_12C	3/9/2006	183		Yes	No	No	-62%	green
0.4	DUD_12C	21-Oct-03	478	J	Yes	No	DuwDiag Jan2005	DUD_12C	2/2/2005	206		Yes	No	No	-57%	green
0.4	DUD_12C	21-Oct-03	478	J	Yes	No	DuwDiagonal March2004	DUD_12C	3/30/2004	266		Yes	No	No	-44%	green

Table 4b. Resampled Surface Sediment at Duwamish/Diagonal EAA Perimeter Stations—cPAHs

	2003 Data (Pre-Construction)						New Data							Location Trend		
RM	Location Name	Sample Date	cPAH (µg TEQ/kg dw)	Qualifier	Detected?	Detected Above RAL (1,000 µg/kg)?	Task Description	Location Name	Sample Date	cPAH (µg TEQ/kg dw)	Qualifier	Detected?	Detected Above RAL (1,000 µg/kg)?	Either Detected Above RAL?	Percent Change	Trend Code for Mapping
0.5	DUD_1C	20-Oct-03	1050	J	Yes	Yes	Duwamish Diagonal 2012	DUD_1C	4/4/2012	290		Yes	No	Yes	-72%	blue
0.5	DUD_1C	20-Oct-03	1050	J	Yes	Yes	Duwamish Diagonal 2011	DUD_1C	3/28/2011	400		Yes	No	Yes	-62%	blue
0.5	DUD_1C	20-Oct-03	1050	J	Yes	Yes	Duwamish Diagonal 2010	DUD_1C	3/29/2010	170		Yes	No	Yes	-84%	blue
0.5	DUD_1C	20-Oct-03	1050	J	Yes	Yes	DuwDiagonal April2009	DUD_1C	4/27/2009	230		Yes	No	Yes	-78%	blue
0.5	DUD_1C	20-Oct-03	1050	J	Yes	Yes	DuwDiagonal March2008	DUD_1C	3/24/2008	430		Yes	No	Yes	-59%	blue
0.5	DUD_1C	20-Oct-03	1050	J	Yes	Yes	DuwDiag March2006	DUD_1C	3/8/2006	463	J	Yes	No	Yes	-56%	blue
0.5	DUD_1C	20-Oct-03	1050	J	Yes	Yes	DuwDiag Jan2005	DUD_1C	2/1/2005	339		Yes	No	Yes	-68%	blue
0.5	DUD_1C	20-Oct-03	1050	J	Yes	Yes	DuwDiagonal March2004	DUD_1C	3/29/2004	142		Yes	No	Yes	-86%	blue
0.6	DUD_2C	20-Oct-03	1020	J	Yes	Yes	Duwamish Diagonal 2011	DUD_2C	3/28/2011	740		Yes	No	Yes	-27%	gray
0.6	DUD_2C	20-Oct-03	1020	J	Yes	Yes	Duwamish Diagonal 2010	DUD_2C	3/29/2010	270		Yes	No	Yes	-74%	blue
0.6	DUD_2C	20-Oct-03	1020	J	Yes	Yes	DuwDiagonal April2009	DUD_2C	4/27/2009	250	J	Yes	No	Yes	-75%	blue
0.6	DUD_2C	20-Oct-03	1020	J	Yes	Yes	DuwDiagonal March2008	DUD_2C	3/24/2008	620		Yes	No	Yes	-39%	gray
0.6	DUD_2C	20-Oct-03	1020	J	Yes	Yes	DuwDiag March2006	DUD_2C	3/8/2006	847		Yes	No	Yes	-17%	gray
0.6	DUD_2C	20-Oct-03	1020	J	Yes	Yes	DuwDiag Jan2005	DUD_2C	1/31/2005	513		Yes	No	Yes	-50%	gray
0.6	DUD_2C	20-Oct-03	1020	J	Yes	Yes	DuwDiagonal March2004	DUD_2C	3/29/2004	258	J	Yes	No	Yes	-75%	blue
0.5	DUD_8C	21-Oct-03	275	J	Yes	No	Duwamish Diagonal 2012	DUD_8C	3/28/2012	270		Yes	No	No	-2%	green
0.5	DUD_8C	21-Oct-03	275	J	Yes	No	Duwamish Diagonal 2010	DUD_8C	3/29/2010	71		Yes	No	No	-74%	green
0.5	DUD_8C	21-Oct-03	275	J	Yes	No	DuwDiagonal April2009	DUD_8C	4/28/2009	100		Yes	No	No	-64%	green
0.5	DUD_8C	21-Oct-03	275	J	Yes	No	DuwDiagonal March2008	DUD_8C	3/24/2008	84		Yes	No	No	-69%	green
0.5	DUD_8C	21-Oct-03	275	J	Yes	No	DuwDiag March2006	DUD_8C	3/8/2006	131		Yes	No	No	-52%	green
0.5	DUD_8C	21-Oct-03	275	J	Yes	No	DuwDiag Jan2005	DUD_8C	2/1/2005	215		Yes	No	No	-22%	green
0.5	DUD_8C	21-Oct-03	275	J	Yes	No	DuwDiagonal March2004	DUD_8C	3/30/2004	228	J	Yes	No	No	-17%	green

Table 4b. Resampled Surface Sediment at Duwamish/Diagonal EAA Perimeter Stations—cPAHs

	2003 Data (Pre-Construction)						New Data							Location Trend		
RM	Location Name	Sample Date	cPAH (µg TEQ/kg dw)	Qualifier	Detected?	Detected Above RAL (1,000 µg/kg)?	Task Description	Location Name	Sample Date	cPAH (µg TEQ/kg dw)	Qualifier	Detected?	Detected Above RAL (1,000 µg/kg)?	Either Detected Above RAL?	Percent Change	Trend Code for Mapping
0.4	DUD_9C	21-Oct-03	246	J	Yes	No	Duwamish Diagonal 2012	DUD_9C	3/28/2012	160		Yes	No	No	-35%	green
0.4	DUD_9C	21-Oct-03	246	J	Yes	No	Duwamish Diagonal 2011	DUD_9C	3/28/2011	140		Yes	No	No	-43%	green
0.4	DUD_9C	21-Oct-03	246	J	Yes	No	Duwamish Diagonal 2010	DUD_9C	3/29/2010	95		Yes	No	No	-61%	green
0.4	DUD_9C	21-Oct-03	246	J	Yes	No	DuwDiagonal April2009	DUD_9C	4/29/2009	49		Yes	No	No	-80%	green
0.4	DUD_9C	21-Oct-03	246	J	Yes	No	DuwDiagonal March2008	DUD_9C	3/24/2008	100		Yes	No	No	-59%	green
0.4	DUD_9C	21-Oct-03	246	J	Yes	No	DuwDiag March2006	DUD_9C	3/8/2006	136		Yes	No	No	-45%	green
0.4	DUD_9C	21-Oct-03	246	J	Yes	No	DuwDiag Jan2005	DUD_9C	1/31/2005	202		Yes	No	No	-18%	green
0.4	DUD_9C	21-Oct-03	246	J	Yes	No	DuwDiagonal March2004	DUD_9C	3/30/2004	179	J	Yes	No	No	-27%	green

Notes:

No cPAH data in 2007.

Trend Code for Mapping: If neither sample has concentrations detected above the RAL, code as "green" and do not evaluate trends. Blue = concentration decrease >50%.

Font color in "Percent Change" column uses the above Trend Code criteria with the exception of assigning green to locations below the RAL. (i.e., locations below the RAL are colored by the concentration change instead of green.)

Gray = concentration change less than 50%. Red = concentration increase > 50%.

dw = dry weight
EAA = early action area
cPAH = carcinogenic polycyclic aromatic hydrocarbon
RAL = remedial action level
RM = river mile
TEQ = toxicity equivalent

Table 4c. Resampled Surface Sediment at Duwamish/Diagonal EAA Perimeter Stations—Arsenic

	2003 Data (Pre-Construction)						New Data							Location Trend		
RM	Location Name	Sample Date	Arsenic (mg/kg dw)	Qualifier	Detected?	Detected Above SCO?	Task Description	Location Name	Sample Date	Arsenic (mg/kg dw)	Qualifier	Detected?	Detected Above SCO?	Either Detected Above SCO?	Percent Change	Trend Code for Mapping
0.4	DUD_10C	21-Oct-03	24.4	J	Yes	No	Duwamish Diagonal 2012	DUD_10C	28-Mar-12	14.7		Yes	No	No	-40%	green
0.4	DUD_10C	21-Oct-03	24.4	J	Yes	No	Duwamish Diagonal 2011	DUD_10C	28-Mar-11	11.1		Yes	No	No	-55%	green
0.4	DUD_10C	21-Oct-03	24.4	J	Yes	No	Duwamish Diagonal 2010	DUD_10C	29-Mar-10	10	J	Yes	No	No	-59%	green
0.4	DUD_10C	21-Oct-03	24.4	J	Yes	No	DuwDiagonal April2009	DUD_10C	29-Apr-09	8.9	J	Yes	No	No	-64%	green
0.4	DUD_10C	21-Oct-03	24.4	J	Yes	No	DuwDiagonal March2008	DUD_10C	24-Mar-08	9.62		Yes	No	No	-61%	green
0.4	DUD_10C	21-Oct-03	24.4	J	Yes	No	DuwDiagonal April 2007	DUD_10C	02-Apr-07	10	J	Yes	No	No	-59%	green
0.4	DUD_10C	21-Oct-03	24.4	J	Yes	No	DuwDiag March2006	DUD_10C	08-Mar-06	9.9	J	Yes	No	No	-59%	green
0.4	DUD_10C	21-Oct-03	24.4	J	Yes	No	DuwDiag Jan2005	DUD_10C	01-Feb-05	10		Yes	No	No	-59%	green
0.4	DUD_10C	21-Oct-03	24.4	J	Yes	No	DuwDiagonal March2004	DUD_10C	30-Mar-04	7.4	J	Yes	No	No	-70%	green
0.4	DUD_11C	21-Oct-03	23.9	J	Yes	No	Duwamish Diagonal 2012	DUD_11C	28-Mar-12	9.3	J	Yes	No	No	-61%	green
0.4	DUD_11C	21-Oct-03	23.9	J	Yes	No	Duwamish Diagonal 2011	DUD_11C	28-Mar-11	8.2	J	Yes	No	No	-66%	green
0.4	DUD_11C	21-Oct-03	23.9	J	Yes	No	Duwamish Diagonal 2010	DUD_11C	30-Mar-10	6.6	J	Yes	No	No	-72%	green
0.4	DUD_11C	21-Oct-03	23.9	J	Yes	No	DuwDiagonal April2009	DUD_11C	29-Apr-09	7.4	J	Yes	No	No	-69%	green
0.4	DUD_11C	21-Oct-03	23.9	J	Yes	No	DuwDiagonal March2008	DUD_11C	25-Mar-08	5.5	J	Yes	No	No	-77%	green
0.4	DUD_11C	21-Oct-03	23.9	J	Yes	No	DuwDiagonal April 2007	DUD_11C	02-Apr-07	8.7	J	Yes	No	No	-64%	green
0.4	DUD_11C	21-Oct-03	23.9	J	Yes	No	DuwDiag March2006	DUD_11C	09-Mar-06	4.4	J	Yes	No	No	-82%	green
0.4	DUD_11C	21-Oct-03	23.9	J	Yes	No	DuwDiag Jan2005	DUD_11C	01-Feb-05	3	U	No	No	No	-87%	green
0.4	DUD_11C	21-Oct-03	23.9	J	Yes	No	DuwDiagonal March2004	DUD_11C	30-Mar-04	1.65	U	No	No	No	-93%	green
0.4	DUD_12C	21-Oct-03	23.1	J	Yes	No	Duwamish Diagonal 2012	DUD_12C	28-Mar-12	8.1	J	Yes	No	No	-65%	green
0.4	DUD_12C	21-Oct-03	23.1	J	Yes	No	Duwamish Diagonal 2011	DUD_12C	29-Mar-11	8.6	J	Yes	No	No	-63%	green
0.4	DUD_12C	21-Oct-03	23.1	J	Yes	No	Duwamish Diagonal 2010	DUD_12C	30-Mar-10	9.1	J	Yes	No	No	-61%	green
0.4	DUD_12C	21-Oct-03	23.1	J	Yes	No	DuwDiagonal April2009	DUD_12C	29-Apr-09	9.1	J	Yes	No	No	-61%	green
0.4	DUD_12C	21-Oct-03	23.1	J	Yes	No	DuwDiagonal March2008	DUD_12C	25-Mar-08	12		Yes	No	No	-48%	green
0.4	DUD_12C	21-Oct-03	23.1	J	Yes	No	DuwDiagonal April 2007	DUD_12C	02-Apr-07	7.2	J	Yes	No	No	-69%	green
0.4	DUD_12C	21-Oct-03	23.1	J	Yes	No	DuwDiag March2006	DUD_12C	09-Mar-06	6.9	J	Yes	No	No	-70%	green
0.4	DUD_12C	21-Oct-03	23.1	J	Yes	No	DuwDiag Jan2005	DUD_12C	02-Feb-05	4.8		Yes	No	No	-79%	green
0.4	DUD_12C	21-Oct-03	23.1	J	Yes	No	DuwDiagonal March2004	DUD_12C	30-Mar-04	3.5	U	No	No	No	-85%	green

Table 4c. Resampled Surface Sediment at Duwamish/Diagonal EAA Perimeter Stations—Arsenic

	2003 Data (Pre-Construction)						New Data							Location Trend		
RM	Location Name	Sample Date	Arsenic (mg/kg dw)	Qualifier	Detected?	Detected Above SCO?	Task Description	Location Name	Sample Date	Arsenic (mg/kg dw)	Qualifier	Detected?	Detected Above SCO?	Either Detected Above SCO?	Percent Change	Trend Code for Mapping
0.5	DUD_1C	20-Oct-03	29	J	Yes	No	Duwamish Diagonal 2012	DUD_1C	04-Apr-12	12	J	Yes	No	No	-59%	green
0.5	DUD_1C	20-Oct-03	29	J	Yes	No	Duwamish Diagonal 2011	DUD_1C	28-Mar-11	14	J	Yes	No	No	-52%	green
0.5	DUD_1C	20-Oct-03	29	J	Yes	No	Duwamish Diagonal 2010	DUD_1C	29-Mar-10	13	J	Yes	No	No	-55%	green
0.5	DUD_1C	20-Oct-03	29	J	Yes	No	DuwDiagonal April2009	DUD_1C	27-Apr-09	14	J	Yes	No	No	-52%	green
0.5	DUD_1C	20-Oct-03	29	J	Yes	No	DuwDiagonal March2008	DUD_1C	24-Mar-08	15.2		Yes	No	No	-48%	green
0.5	DUD_1C	20-Oct-03	29	J	Yes	No	DuwDiagonal April 2007	DUD_1C	02-Apr-07	14	J	Yes	No	No	-52%	green
0.5	DUD_1C	20-Oct-03	29	J	Yes	No	DuwDiag March2006	DUD_1C	08-Mar-06	11	J	Yes	No	No	-62%	green
0.5	DUD_1C	20-Oct-03	29	J	Yes	No	DuwDiag Jan2005	DUD_1C	01-Feb-05	6.1		Yes	No	No	-79%	green
0.5	DUD_1C	20-Oct-03	29	J	Yes	No	DuwDiagonal March2004	DUD_1C	29-Mar-04	3.6	U	No	No	No	-88%	green
0.6	DUD_2C	20-Oct-03	28	J	Yes	No	Duwamish Diagonal 2011	DUD_2C	28-Mar-11	13.9		Yes	No	No	-50%	green
0.6	DUD_2C	20-Oct-03	28	J	Yes	No	Duwamish Diagonal 2010	DUD_2C	29-Mar-10	13	J	Yes	No	No	-54%	green
0.6	DUD_2C	20-Oct-03	28	J	Yes	No	DuwDiagonal April2009	DUD_2C	27-Apr-09	12	J	Yes	No	No	-57%	green
0.6	DUD_2C	20-Oct-03	28	J	Yes	No	DuwDiagonal March2008	DUD_2C	24-Mar-08	14.6		Yes	No	No	-48%	green
0.6	DUD_2C	20-Oct-03	28	J	Yes	No	DuwDiagonal April 2007	DUD_2C	02-Apr-07	13	J	Yes	No	No	-54%	green
0.6	DUD_2C	20-Oct-03	28	J	Yes	No	DuwDiag March2006	DUD_2C	08-Mar-06	13	J	Yes	No	No	-54%	green
0.6	DUD_2C	20-Oct-03	28	J	Yes	No	DuwDiag Jan2005	DUD_2C	31-Jan-05	7.5		Yes	No	No	-73%	green
0.6	DUD_2C	20-Oct-03	28	J	Yes	No	DuwDiagonal March2004	DUD_2C	29-Mar-04	3.7	U	No	No	No	-87%	green
0.5	DUD_8C	21-Oct-03	35.7	J	Yes	No	Duwamish Diagonal 2012	DUD_8C	28-Mar-12	14.8		Yes	No	No	-59%	green
0.5	DUD_8C	21-Oct-03	35.7	J	Yes	No	Duwamish Diagonal 2011	DUD_8C	28-Mar-11	10		Yes	No	No	-72%	green
0.5	DUD_8C	21-Oct-03	35.7	J	Yes	No	Duwamish Diagonal 2010	DUD_8C	29-Mar-10	11.5		Yes	No	No	-68%	green
0.5	DUD_8C	21-Oct-03	35.7	J	Yes	No	DuwDiagonal April2009	DUD_8C	28-Apr-09	15.6		Yes	No	No	-56%	green
0.5	DUD_8C	21-Oct-03	35.7	J	Yes	No	DuwDiagonal March2008	DUD_8C	24-Mar-08	5.5	J	Yes	No	No	-85%	green
0.5	DUD_8C	21-Oct-03	35.7	J	Yes	No	DuwDiagonal April 2007	DUD_8C	02-Apr-07	7.3	J	Yes	No	No	-80%	green
0.5	DUD_8C	21-Oct-03	35.7	J	Yes	No	DuwDiag March2006	DUD_8C	08-Mar-06	5.2	J	Yes	No	No	-85%	green
0.5	DUD_8C	21-Oct-03	35.7	J	Yes	No	DuwDiag Jan2005	DUD_8C	01-Feb-05	6.4		Yes	No	No	-82%	green
0.5	DUD_8C	21-Oct-03	35.7	J	Yes	No	DuwDiagonal March2004	DUD_8C	30-Mar-04	3.7	U	No	No	No	-90%	green
0.4	DUD_9C	21-Oct-03	14	J	Yes	No	Duwamish Diagonal 2012	DUD_9C	28-Mar-12	9.4		Yes	No	No	-33%	green

Table 4c. Resampled Surface Sediment at Duwamish/Diagonal EAA Perimeter Stations—Arsenic

	2003 Data (Pre-Construction)						New Data							Location Trend		
RM	Location Name	Sample Date	Arsenic (mg/kg dw)	Qualifier	Detected?	Detected Above SCO?	Task Description	Location Name	Sample Date	Arsenic (mg/kg dw)	Qualifier	Detected?	Detected Above SCO?	Either Detected Above SCO?	Percent Change	Trend Code for Mapping
0.4	DUD_9C	21-Oct-03	14	J	Yes	No	Duwamish Diagonal 2011	DUD_9C	28-Mar-11	9.1	J	Yes	No	No	-35%	green
0.4	DUD_9C	21-Oct-03	14	J	Yes	No	Duwamish Diagonal 2010	DUD_9C	29-Mar-10	5.7	J	Yes	No	No	-59%	green
0.4	DUD_9C	21-Oct-03	14	J	Yes	No	DuwDiagonal April2009	DUD_9C	29-Apr-09	7.4	J	Yes	No	No	-47%	green
0.4	DUD_9C	21-Oct-03	14	J	Yes	No	DuwDiagonal March2008	DUD_9C	24-Mar-08	6.2	J	Yes	No	No	-56%	green
0.4	DUD_9C	21-Oct-03	14	J	Yes	No	DuwDiagonal April 2007	DUD_9C	02-Apr-07	6.9	J	Yes	No	No	-51%	green
0.4	DUD_9C	21-Oct-03	14	J	Yes	No	DuwDiag March2006	DUD_9C	08-Mar-06	5.1	J	Yes	No	No	-64%	green
0.4	DUD_9C	21-Oct-03	14	J	Yes	No	DuwDiag Jan2005	DUD_9C	31-Jan-05	7.9		Yes	No	No	-44%	green
0.4	DUD_9C	21-Oct-03	14	J	Yes	No	DuwDiagonal March2004	DUD_9C	30-Mar-04	3.5	U	No	No	No	-75%	green

Notes:

Trend Code for Mapping: If neither sample has concentrations detected above the benthic SCO, code as "green" and do not evaluate trends. Blue = concentration decrease >50%.
Font color in "Percent Change" column uses the above Trend Code criteria with the exception of assigning green to locations below the benthic SCO. (i.e., locations below the benthic SCO are colored by the concentration change instead of gree
Gray = concentration change less than 50%. Red = concentration increase > 50%.
Undetected data are reported at the reporting limit.

dw = dry weight
EAA = early action area
RM = river mile
SCO = sediment cleanup objective (benthic: 57 mg/kg dw)

Table 4d. Resampled Surface Sediment at Duwamish/Diagonal EAA Perimeter Stations—BEHP

	2003 Data (Pre-Construction)								New Data										Location Trend		
RM	Location Name	Sample Date	BEHP (µg/kg dw)	Qualifier	Detected?	Exceeds SCO?	Exceeds CSL?	Detected Above SCO?	Task Description	Location Name	Sample Date	BEHP (µg/kg dw)	Qualifier	Detected?	Exceeds SCO?	Exceeds CSL?	Detected Above SCO?	Either Detected Above SCO?	Percent Change	Trend Code for Mapping
0.4	DUD_10C	21-Oct-03	463		Yes	No	No	No	Duwamish Diagonal 2012	DUD_10C	3/28/2012	314		Yes	No	No	No	No	-32%	green
0.4	DUD_10C	21-Oct-03	463		Yes	No	No	No	Duwamish Diagonal 2011	DUD_10C	3/28/2011	315		Yes	No	No	No	No	-32%	green
0.4	DUD_10C	21-Oct-03	463		Yes	No	No	No	Duwamish Diagonal 2010	DUD_10C	3/29/2010	140	U	No	No	No	No	No	-70%	green
0.4	DUD_10C	21-Oct-03	463		Yes	No	No	No	DuwDiagonal April2009	DUD_10C	4/29/2009	306	U	No	No	No	No	No	-34%	green
0.4	DUD_10C	21-Oct-03	463		Yes	No	No	No	DuwDiagonal March2008	DUD_10C	3/24/2008	329		Yes	No	No	No	No	-29%	green
0.4	DUD_10C	21-Oct-03	463		Yes	No	No	No	DuwDiagonal April 2007	DUD_10C	4/2/2007	249		Yes	No	No	No	No	-46%	green
0.4	DUD_10C	21-Oct-03	463		Yes	No	No	No	DuwDiag March2006	DUD_10C	3/8/2006	450		Yes	Yes	No	Yes	Yes	-3%	gray
0.4	DUD_10C	21-Oct-03	463		Yes	No	No	No	DuwDiag Jan2005	DUD_10C	2/1/2005	301		Yes	No	No	No	No	-35%	green
0.4	DUD_10C	21-Oct-03	463		Yes	No	No	No	DuwDiagonal March2004	DUD_10C	3/30/2004	540		Yes	Yes	No	Yes	Yes	17%	gray
0.4	DUD_11C	21-Oct-03	1610		Yes	Yes	Yes	Yes	Duwamish Diagonal 2012	DUD_11C	3/28/2012	640		Yes	No	No	No	Yes	-60%	blue
0.4	DUD_11C	21-Oct-03	1610		Yes	Yes	Yes	Yes	Duwamish Diagonal 2011	DUD_11C	3/28/2011	758	J	Yes	Yes	No	Yes	Yes	-53%	blue
0.4	DUD_11C	21-Oct-03	1610		Yes	Yes	Yes	Yes	Duwamish Diagonal 2010	DUD_11C	3/30/2010	344		Yes	No	No	No	Yes	-79%	blue
0.4	DUD_11C	21-Oct-03	1610		Yes	Yes	Yes	Yes	DuwDiagonal April2009	DUD_11C	4/29/2009	1150		Yes	Yes	Yes	Yes	Yes	-29%	gray
0.4	DUD_11C	21-Oct-03	1610		Yes	Yes	Yes	Yes	DuwDiagonal March2008	DUD_11C	3/25/2008	559		Yes	Yes	Yes	Yes	Yes	-65%	blue
0.4	DUD_11C	21-Oct-03	1610		Yes	Yes	Yes	Yes	DuwDiagonal April 2007	DUD_11C	4/2/2007	517		Yes	No	No	No	Yes	-68%	blue
0.4	DUD_11C	21-Oct-03	1610		Yes	Yes	Yes	Yes	DuwDiag March2006	DUD_11C	3/9/2006	755		Yes	Yes	Yes	Yes	Yes	-53%	blue
0.4	DUD_11C	21-Oct-03	1610		Yes	Yes	Yes	Yes	DuwDiag Jan2005	DUD_11C	2/1/2005	62.2		Yes	No	No	No	Yes	-96%	blue
0.4	DUD_11C	21-Oct-03	1610		Yes	Yes	Yes	Yes	DuwDiagonal March2004	DUD_11C	3/30/2004	52	J	Yes	No	No	No	Yes	-97%	blue
0.4	DUD_12C	21-Oct-03	988		Yes	Yes	No	Yes	Duwamish Diagonal 2012	DUD_12C	3/28/2012	500		Yes	No	No	No	Yes	-49%	gray
0.4	DUD_12C	21-Oct-03	988		Yes	Yes	No	Yes	Duwamish Diagonal 2011	DUD_12C	3/29/2011	653		Yes	No	No	No	Yes	-34%	gray
0.4	DUD_12C	21-Oct-03	988		Yes	Yes	No	Yes	Duwamish Diagonal 2010	DUD_12C	3/30/2010	322		Yes	No	No	No	Yes	-67%	blue
0.4	DUD_12C	21-Oct-03	988		Yes	Yes	No	Yes	DuwDiagonal April2009	DUD_12C	4/29/2009	466	U	No	No	No	No	Yes	-53%	blue
0.4	DUD_12C	21-Oct-03	988		Yes	Yes	No	Yes	DuwDiagonal March2008	DUD_12C	3/25/2008	958		Yes	Yes	No	Yes	Yes	-3%	gray
0.4	DUD_12C	21-Oct-03	988		Yes	Yes	No	Yes	DuwDiagonal April 2007	DUD_12C	4/2/2007	468		Yes	Yes	No	Yes	Yes	-53%	blue
0.4	DUD_12C	21-Oct-03	988		Yes	Yes	No	Yes	DuwDiag March2006	DUD_12C	3/9/2006	668		Yes	Yes	Yes	Yes	Yes	-32%	gray

Table 4d. Resampled Surface Sediment at Duwamish/Diagonal EAA Perimeter Stations—BEHP

	2003 Data (Pre-Construction)								New Data									Location Trend		
RM	Location Name	Sample Date	BEHP (µg/kg dw)	Qualifier	Detected?	Exceeds SCO?	Exceeds CSL?	Detected Above SCO?	Task Description	Location Name	Sample Date	BEHP (µg/kg dw)	Qualifier	Detected?	Exceeds SCO?	Exceeds CSL?	Detected Above SCO?	Either Detected Above SCO?	Percent Change	Trend Code for Mapping
0.4	DUD_12C	21-Oct-03	988		Yes	Yes	No	Yes	DuwDiag Jan2005	DUD_12C	2/2/2005	441		Yes	Yes	No	Yes	Yes	-55%	blue
0.4	DUD_12C	21-Oct-03	988		Yes	Yes	No	Yes	DuwDiagonal March2004	DUD_12C	3/30/2004	770		Yes	Yes	Yes	Yes	Yes	-22%	gray
0.5	DUD_1C	20-Oct-03	5940		Yes	Yes	Yes	Yes	Duwamish Diagonal 2012	DUD_1C	4/4/2012	839		Yes	No	No	No	Yes	-86%	blue
0.5	DUD_1C	20-Oct-03	5940		Yes	Yes	Yes	Yes	Duwamish Diagonal 2011	DUD_1C	3/28/2011	1660		Yes	Yes	No	Yes	Yes	-72%	blue
0.5	DUD_1C	20-Oct-03	5940		Yes	Yes	Yes	Yes	Duwamish Diagonal 2010	DUD_1C	3/29/2010	714		Yes	No	No	No	Yes	-88%	blue
0.5	DUD_1C	20-Oct-03	5940		Yes	Yes	Yes	Yes	DuwDiagonal April2009	DUD_1C	4/27/2009	592	U	No	No	No	No	Yes	-90%	blue
0.5	DUD_1C	20-Oct-03	5940		Yes	Yes	Yes	Yes	DuwDiagonal March2008	DUD_1C	3/24/2008	2330		Yes	Yes	Yes	Yes	Yes	-61%	blue
0.5	DUD_1C	20-Oct-03	5940		Yes	Yes	Yes	Yes	DuwDiagonal April 2007	DUD_1C	4/2/2007	1440	J	Yes	Yes	No	Yes	Yes	-76%	blue
0.5	DUD_1C	20-Oct-03	5940		Yes	Yes	Yes	Yes	DuwDiag March2006	DUD_1C	3/8/2006	2360		Yes	Yes	Yes	Yes	Yes	-60%	blue
0.5	DUD_1C	20-Oct-03	5940		Yes	Yes	Yes	Yes	DuwDiag Jan2005	DUD_1C	2/1/2005	877		Yes	Yes	No	Yes	Yes	-85%	blue
0.5	DUD_1C	20-Oct-03	5940		Yes	Yes	Yes	Yes	DuwDiagonal March2004	DUD_1C	3/29/2004	676		Yes	Yes	Yes	Yes	Yes	-89%	blue
0.6	DUD_2C	20-Oct-03	2700		Yes	Yes	Yes	Yes	Duwamish Diagonal 2011	DUD_2C	3/28/2011	926		Yes	No	No	No	Yes	-66%	blue
0.6	DUD_2C	20-Oct-03	2700		Yes	Yes	Yes	Yes	Duwamish Diagonal 2010	DUD_2C	3/29/2010	513		Yes	No	No	No	Yes	-81%	blue
0.6	DUD_2C	20-Oct-03	2700		Yes	Yes	Yes	Yes	DuwDiagonal April2009	DUD_2C	4/27/2009	482	U	No	Yes	Yes	No	Yes	-82%	blue
0.6	DUD_2C	20-Oct-03	2700		Yes	Yes	Yes	Yes	DuwDiagonal March2008	DUD_2C	3/24/2008	1580		Yes	Yes	No	Yes	Yes	-41%	gray
0.6	DUD_2C	20-Oct-03	2700		Yes	Yes	Yes	Yes	DuwDiagonal April 2007	DUD_2C	4/2/2007	805		Yes	No	No	No	Yes	-70%	blue
0.6	DUD_2C	20-Oct-03	2700		Yes	Yes	Yes	Yes	DuwDiag March2006	DUD_2C	3/8/2006	1770		Yes	Yes	Yes	Yes	Yes	-34%	gray
0.6	DUD_2C	20-Oct-03	2700		Yes	Yes	Yes	Yes	DuwDiag Jan2005	DUD_2C	1/31/2005	1040		Yes	Yes	No	Yes	Yes	-61%	blue
0.6	DUD_2C	20-Oct-03	2700		Yes	Yes	Yes	Yes	DuwDiagonal March2004	DUD_2C	3/29/2004	896		Yes	No	No	No	Yes	-67%	blue
0.5	DUD_8C	21-Oct-03	2420		Yes	Yes	Yes	Yes	Duwamish Diagonal 2012	DUD_8C	3/28/2012	1170		Yes	Yes	Yes	Yes	Yes	-52%	blue
0.5	DUD_8C	21-Oct-03	2420		Yes	Yes	Yes	Yes	Duwamish Diagonal 2011	DUD_8C	3/28/2011	720		Yes	Yes	No	Yes	Yes	-70%	blue
0.5	DUD_8C	21-Oct-03	2420		Yes	Yes	Yes	Yes	Duwamish Diagonal 2010	DUD_8C	3/29/2010	459		Yes	No	No	No	Yes	-81%	blue
0.5	DUD_8C	21-Oct-03	2420		Yes	Yes	Yes	Yes	DuwDiagonal April2009	DUD_8C	4/28/2009	948		Yes	Yes	Yes	Yes	Yes	-61%	blue
0.5	DUD_8C	21-Oct-03	2420		Yes	Yes	Yes	Yes	DuwDiagonal March2008	DUD_8C	3/24/2008	400		Yes	Yes	No	Yes	Yes	-83%	blue
0.5	DUD_8C	21-Oct-03	2420		Yes	Yes	Yes	Yes	DuwDiagonal April 2007	DUD_8C	4/2/2007	255		Yes	No	No	No	Yes	-89%	blue

Table 4d. Resampled Surface Sediment at Duwamish/Diagonal EAA Perimeter Stations—BEHP

	2003 Data (Pre-Construction)								New Data									Location Trend		
RM	Location Name	Sample Date	BEHP (µg/kg dw)	Qualifier	Detected?	Exceeds SCO?	Exceeds CSL?	Detected Above SCO?	Task Description	Location Name	Sample Date	BEHP (µg/kg dw)	Qualifier	Detected?	Exceeds SCO?	Exceeds CSL?	Detected Above SCO?	Either Detected Above SCO?	Percent Change	Trend Code for Mapping
0.5	DUD_8C	21-Oct-03	2420		Yes	Yes	Yes	Yes	DuwDiag March2006	DUD_8C	3/8/2006	405		Yes	No	No	No	Yes	-83%	blue
0.5	DUD_8C	21-Oct-03	2420		Yes	Yes	Yes	Yes	DuwDiag Jan2005	DUD_8C	2/1/2005	763		Yes	Yes	No	Yes	Yes	-68%	blue
0.5	DUD_8C	21-Oct-03	2420		Yes	Yes	Yes	Yes	DuwDiagonal March2004	DUD_8C	3/30/2004	1110		Yes	No	No	No	Yes	-54%	blue
0.4	DUD_9C	21-Oct-03	473		Yes	Yes	No	Yes	Duwamish Diagonal 2012	DUD_9C	3/28/2012	334		Yes	No	No	No	Yes	-29%	gray
0.4	DUD_9C	21-Oct-03	473		Yes	Yes	No	Yes	Duwamish Diagonal 2011	DUD_9C	3/28/2011	531		Yes	No	No	No	Yes	12%	gray
0.4	DUD_9C	21-Oct-03	473		Yes	Yes	No	Yes	Duwamish Diagonal 2010	DUD_9C	3/29/2010	201		Yes	No	No	No	Yes	-58%	blue
0.4	DUD_9C	21-Oct-03	473		Yes	Yes	No	Yes	DuwDiagonal April2009	DUD_9C	4/29/2009	232	U	No	Yes	Yes	No	Yes	-51%	blue
0.4	DUD_9C	21-Oct-03	473		Yes	Yes	No	Yes	DuwDiagonal March2008	DUD_9C	3/24/2008	393		Yes	Yes	No	Yes	Yes	-17%	gray
0.4	DUD_9C	21-Oct-03	473		Yes	Yes	No	Yes	DuwDiagonal April 2007	DUD_9C	4/2/2007	156		Yes	No	No	No	Yes	-67%	blue
0.4	DUD_9C	21-Oct-03	473		Yes	Yes	No	Yes	DuwDiag March2006	DUD_9C	3/8/2006	348		Yes	No	No	No	Yes	-26%	gray
0.4	DUD_9C	21-Oct-03	473		Yes	Yes	No	Yes	DuwDiag Jan2005	DUD_9C	1/31/2005	695		Yes	Yes	No	Yes	Yes	47%	gray
0.4	DUD_9C	21-Oct-03	473		Yes	Yes	No	Yes	DuwDiagonal March2004	DUD_9C	3/30/2004	681		Yes	No	No	No	Yes	44%	gray

Notes:
Trend Code for Mapping: If neither sample has concentrations detected above the benthic SCO, code as "green" and do not evaluate trends. Blue = concentration decrease >50%.
Font color in "Percent Change" column uses the above Trend Code criteria with the exception of assigning green to locations below the benthic SCO. (i.e., locations below the benthic SCO are colored by the concentration change instead of green).
Gray = concentration change less than 50%. Red = concentration increase > 50%.
Undetected data are reported at the reporting limit.

BEHP = bis(2-ethylhexyl)phthalate
CSL = cleanup screening level (benthic: 78 mg/kg oc or 1,900 µg/kg dw as defined in RI/FS)
dw = dry weight
EAA = early action area
RM = river mile
SCO = sediment cleanup objective (benthic: 47 mg/kg oc or 1,300 µg/kg dw as defined in RI/FS)

Table 5. Total PCB Trends in New Sediment Cores

Task	Location Name	Sample Name	Sample Date	Upper Depth (ft)	Lower Depth (ft)	Total PCBs (µg/kg dw)	Qualifier	Percent Change (with Depth)	Map Color
Glacier Northwest - Reichhold RI/FS	SED-SC-04	SED-SC-04-0-1-053012	30-May-12	0	1	530		104%	red
	SED-SC-04	SED-SC-04-1-2-053012	30-May-12	1	2	260			
	SED-SC-07	SED-SC-07-0-1-053012	30-May-12	0	1	260		-66%	blue
	SED-SC-07	SED-SC-07-1-2-053012	30-May-12	1	2	760			
	SED-SC-09	SED-SC-09-0-1-052912	29-May-12	0	1	540		42%	gray
	SED-SC-09	SED-SC-09-1-2-052912	29-May-12	1	2	380			
	SED-SC-14	SED-SC-14-0-1-052912	29-May-12	0	1	1270		408%	red
	SED-SC-14	SED-SC-14-1-2-052912	29-May-12	1	2	250			

Notes:

This table includes cores collected since the FS with sample intervals in the 0-1 and 1-2 ft intervals.

Trend Code: If neither sample has concentrations detected above the benthic SCO, code as "green" and do not evaluate trends. Blue = concentration decrease >50%.
Gray = concentration change less than 50%. Red = concentration increase > 50%.

All data are above the benthic sediment cleanup objective of 130 µg/kg dw or 12 mg/kg oc, so no green assigned.

dw = dry weight
PCB = polychlorinated biphenyl

Table 6. LDW Areas Subject to Waterway User Interviews and Effect on Recovery Category Designations

River Mile	General Location	Berthing Area Changed?	Overwater Structure Changed?	FS Recovery Category	Change to Recovery Category?
Harbor Island Marina, east side	Tug boat berths	no	no	1 and 2	no
Harbor Island Marina, south side	Tug boat and recreational vessel berths	**yes, added area**	no	3	**Change to 2 due to berthing area**
0W	T103 - GC and Cal Portland yards	no	no	2 at berth	no
0.05E	Ash Grove north wharf	no, however not currently used	no, but identified as non-operational during interview and in-water structures survey	1	keep as Category 1 due to <1 cm/year from STM, CSL in top of core SC-2, and mixed/equilibrium recovery trend in core
0.1E	Ash Grove south wharf	no	no	1	no
0.3W	Nucor Steel/General Recycling yard north end of wharf	no	no	1	no
0.4W	Nucor Steel/General Recycling yard south end of wharf	no, however not currently used and in disrepair	no, but identified as non-operational during interview and in-water structures survey	1	keep as Category 1 due to vessel scour
0.5E	T108 - shoreward of Duw/Diag EAA	**yes, added area**	no	3	**Change to 2 shoreward of EAA, due to berthing**
Entire eastern side of Kellogg Island	GC and Manson barge mooring	**yes, added area**	no	3	**Change to 2 due to berthing area**
West side of Kellogg Island	No large vessel use, shallow	no	no	3	no
South end of Kellogg Island	Alaska Marine Lines lay berth	**yes, added area**	no	3	**Change to 2 due to berthing area**
1.0W	LaFarge north wharf	no	no	2	no
Slip 1	Manson	no	no	2	no
RM 1E, outside of Slip 1	Cadman, Manson	no	no	1	no
1.0-1.2W	LaFarge main wharf	no	no	1	no
1.2E	JA Jack	no	no	2	no
1.3-1.4W	AML Yard 1 and AML lease from Duwamish Shipyard	no	no	1	no
1.4-1.5W	CalPortland cement plant, outside of Glacier Bay	no	no	1	no
1.5-1.9W	Terminal 115	no	no	3 over most, 2 at berths, 1 at upstream end	no
1.7E	CalPortland aggregate yard	no	no	1	no
Slip 2, north side (head)	CalPortland aggregate yard	no	no	3, although berthing present, FS empirical data override allowed to move from Cat 2 to 3	no

Table 6. LDW Areas Subject to Waterway User Interviews and Effect on Recovery Category Designations

River Mile	General Location	Berthing Area Changed?	Overwater Structure Changed?	FS Recovery Category	Change to Recovery Category?
Slip 2, south side of mouth	Filter Engineering slip berth	no	no	1	no
1.85-2.0E	Filter Engineering main channel structures	**yes, added areas**	no	3	**Change to 2 due to berthing areas**
2.1W	AML Yard 2 (lay berth)	no	no	2	no
Slip 3	SeaTac Marine slip berths	no	no	mix of 2 and 3	no
RM 2.1E	SeaTac Marine main channel berth	no	no	3	no
RM 2.2E to Myrtle Embayment (RM2.4)	Fox dolphins and Seattle Boiler Works	no	no	2 on most, 1 in embayment	no
RM2.25W, just outside of Trotsky Inlet	Boyer Towing lay berth at dolphins	**yes, added area**	no	2; Category 2 from Trotsky Inlet already covered this area	Area is already Category 2 due to increasing PCBs in core SC-40 and because inlet has highest total PCBs in surface sediment outside of EAAs.
RM2.35W	Former MC Halvorsen Marina - Boyer Towing	**yes, added area**	**yes, marina floats removed; area now berths barges**	3	**Change to 2 due to berthing area; extend Cat 2 in Trotsky Inlet to meet upstream Cat 1**
RM2.4E	Seattle Iron and Metals north area/car turn-around	**yes, removed berth**	no	1	Keep as Category 1 due to vessel scour
RM2.35-2.6W	Boyer Towing berths (multiple)	no	no	1 in scour area; 2 at other berths; 3 in remainder	no
2.5E	Seattle Iron and Metals wharf	no	no, but is undergoing repairs (in-kind replacement)	1	no
RM2.65-2.8W	Pacific Pile mooring	no	no	mix of all three	no
Slip 4, mouth	Waste Management	no new berth added, but berth use has become more frequent	no	3	**Change to 2 due to berthing area**
Slip 4, head	Slip 4 EAA	**yes, removed in EAA**	**yes, removed in EAA**	n/a	n/a
RM2.95W	Silver Bay Logging	**yes, trimmed back berth so that it is only in front of adjacent structure and no longer in front of old barge**	**yes; structure was a permanently moored barge that has been removed**	1 and 3	keep as Cat 1 due to vessel scour
RM2.9-3.7E	Boeing Plant 2 EAA	no	**yes; dolphins removed and Plant 2 building shoreline structures removed**	n/a	n/a
RM3.4-3.5W	South Park Marina	**yes, added area**	**yes; upstream-most portion not replaced after adjacent T-117 EAA work**	3	**Change to 2 due to berthing area**
RM4.0W	Kelly Ryan	**yes, enlarged to cover area in front of all dolphins**	no	1	no

Table 6. LDW Areas Subject to Waterway User Interviews and Effect on Recovery Category Designations

River Mile	General Location	Berthing Area Changed?	Overwater Structure Changed?	FS Recovery Category	Change to Recovery Category?
RM4.1W	Duwamish Yacht Club	**yes, added area**	no	3	**Change to 2 due to berthing area**
RM4.2W	Delta Marine	no	**no**	1	no

Notes:

Areas described in this table were the subjects of the waterway user interviews. This table is not a comprehensive listing of all berthing areas or overwater structures in the LDW.

AML = Alaska Marine Lines
EAA = early action area
FS = Feasibility Study
GC = General Construction
LDW = Lower Duwamish Waterway

APPENDIX A

EFFECTS OF CHANGES IN ESTIMATED UPSTREAM SEDIMENT LOAD ON LOWER DUWAMISH WATERWAY SEDIMENT TRANSPORT MODELING

123 Tice Boulevard, Suite 205
Woodcliff Lake, New Jersey 07677
201.930.9890

ANCHOR QEA

Memorandum

February 12, 2019

To: Kathy Godtfredsen, Windward Environmental

From: Kirk Ziegler, Anchor QEA, LLC

Re: Effects of Changes in Estimated Upstream Sediment Load on Lower Duwamish Waterway Sediment Transport Modeling

Objectives

The objectives of this white paper are to: 1) discuss available information and data related to recent U.S. Geological Survey (USGS) estimates of upstream sediment load; 2) evaluate the impacts of changes in upstream sediment load on model calibration results based on analyses conducted as part of the Remedial Investigation/Feasibility Study; 3) compare the original Lower Duwamish Waterway (LDW) sediment transport model (STM) predictions to revised STM results based on the re-calibrated model with the upstream sediment load reduced by approximately 50% with respect to the original load; and 4) determine if the original conclusions related to LDW sediment transport processes would need to be changed based on the revised STM results.

Recent USGS Estimates of Upstream Sediment Load

The USGS conducted a recent suspended-sediment transport study on the Green-Duwamish River from February 2013 to January 2017 (USGS 2018). Turbidity, discharge (river flow rate), suspended-sediment concentration (SSC), and particle-size data were collected within the tidal influence at river kilometer 16.7 (USGS stream gauge 12113390; Duwamish River at Golf Course in Tukwila). A regression model (i.e., rating curve) between SSC and discharge measured during the study period was developed by USGS (see Figure 1). USGS used this regression model to calculate suspended-sediment loads from the computed SSC and time-series discharge data for every 15-minute interval during the study period. The USGS analysis produced an average annual suspended-sediment load of approximately 106,400 metric tons/year (MT/year) for the 3-year period from 2014 to 2016.

In addition to developing estimates of suspended-sediment loads, data corresponding to the relative amount of SSC_{FINES} (i.e., clay/silt particles with diameters less than 62.5 microns) in the suspended-sediment load were collected during the USGS study. Grain size distribution within the clay-silt size range was not measured by the USGS. Table 2 in the USGS report presents 32 values of SSC and SSC_{FINES} obtained between February 2013 and January 2017. The average SSC_{FINES} content for this dataset was 77% (95% confidence interval of 73% to 81%), with a range of 44% to 95%. Thus, the coarse solids content (i.e., particles with diameters greater than 62.5 microns) of the suspended-solids load had an average value of 23%, with a range of 5% to 56%.

Key Takeaways

- The USGS collected data during a multi-year (2013 to 2017) field study that was used to develop an estimate for the upstream sediment load of 106,400 MT/year for the 3-year period from 2014 to 2016.
- The coarse solids content of the suspended-solids load had an average value of 23%, with a range of 5% to 56%.

Overview of Upstream Sediment Load Estimation for Specifying STM Inputs

The method for estimating upstream sediment loads for the specification of STM inputs was described in Appendix B.2 (Boundary Conditions: Upstream Sediment Loads) of the final STM report (QEA 2008). A summary of that method is provided below.

Sediment loads in the Green River were estimated for specification of the upstream inflow boundary in the STM. The USGS conducted sediment loading studies in the Green River during 1965 to 1966 and 1996 to 1997 (Harper-Owes 1981; Embrey and Frans 2003). SSC data were collected over a wide range of flow rates during those studies, including high-flow events with flow rates of approximately 11,000 cubic feet per second (cfs). An analysis of the 1965 to 1966 data is presented in Harper-Owes (1981). That analysis produced the sediment load rating curve shown in the following equation:

$$L_{sus} = 0.107\,Q^{2.09} \qquad (1)$$

where:

L_{sus} = suspended-sediment load (pounds per day)

Q = daily-average flow rate (cfs)

The results of an analysis of the 1996 to 1997 data are given in Embrey and Frans (2003). In that study, the Linear Attribution Estimate (LAE) method was used to develop a regression equation (Embrey and Frans 2003), which was modified for use in this study, shown in the following equations:

$$\ln(L_{sus}) = 13.4 + 1.8916\,\ln(Q^*) + 0.33201\,\ln^2(Q^*) \qquad (2)$$

and

$$\ln(Q^*) = \ln(Q) - \ln(Q_{ave}) \qquad (3)$$

where:

Q_{ave} = average flow rate during the study period, which was 1,800 cfs

Equations 1 and 2 were combined to estimate sediment load in the Green River as follows. For flow rates less than the long-term average value (1,340 cfs), the load rating curve from the Harper-Owes (1981) study was used (i.e., Equation 1). For flow rates greater than the average value, the LAE method was applied (i.e., Equation 2). For calculation of suspended-sediment load in the Green River, flow rates measured at the USGS gauging station at Auburn were used to specify model inputs for the 21-year period used for STM calibration.

Key Takeaways

- The original approach used to estimate the upstream sediment load for the original STM calibration was based on USGS studies conducted during 1965 to 1966 and 1996 to 1997.
- For comparison purposes in this memorandum, this original approach was also used to calculate the average upstream sediment load for the 3-year period from 2014 to 2016. The average estimate for this 3-year period was 191,600 MT/year, which is approximately 80% greater than the average load estimated by USGS during that period (106,400 MT/year).

Overview of STM Development and Application

Development, original calibration, application, and revised calibration of the STM were conducted between 2005 and 2009. Major milestones during this period were the following:

- March 2005 – U.S. Environmental Protection Agency (USEPA) provides EFDC model to Lower Duwamish Waterway Group (LDWG)
- January 2006 – Scoping for STM
- April 2006 – Draft Final Sediment Transport Analysis Report (STAR) submitted to USEPA (Windward and QEA 2007)
- November 2006 – STM Milestone Meeting 1 with USEPA and LDWG modeling teams
- July 2007 – Draft STM report submitted to USEPA
- October 2008 – Final STM report (QEA 2008)
- September 2009 – STM re-calibration using lower upstream sediment loads

The STM group was formed to work collaboratively and provide advice on the development, calibration, and application of the STM. Members of this group included the following:

- Shane Cherry (Cherry Creek Environmental, Inc.)
- Karl Eriksen (U.S. Army Corps of Engineers [USACE])
- Joe Gailani (USACE)
- Earl Hayter (USACE)
- Brad Helland (Washington Department of Ecology)

- Bruce Nairn (King County)
- Mike Riley (S.S. Papadopulos & Associates)
- Peter Rude (City of Seattle)
- Beth Schmoyer (City of Seattle)
- David Schuchardt (City of Seattle)
- Jeff Stern (King County)
- Kym Takasaki (USACE)
- Kirk Ziegler (QEA)

The STM group held four meetings and 13 conference calls (as well as informal discussions) at various times between August 2006 and April 2008 to review STM status and discuss the next steps to be taken in model development, calibration, and application. The intent was to obtain general agreement on the modeling approach, application, and results so that its use in the Feasibility Study would not be subject to debate.

Development, calibration, and application of the STM is fully documented in the final STM report (QEA 2008). An overview of the development and calibration process is provided here. The primary input parameters to the STM are: 1) settling speeds of four sediment size classes (see Table 1); 2) upstream sediment load; and 3) sediment erosion properties. The STM was calibrated over a 21-year period (1960 through 1980). A wide range of upstream flow and tidal conditions occurred during this period, including a 50-year high-flow event during 1975.

Model parameters adjusted during calibration were: 1) settling speeds of Classes 1A and 1B sediment; 2) relative proportions of Classes 1A and 1B in the upstream sediment load; and 3) particle-shielding factor used to adjust erosion rate.

Model output included: 1) deposition and bed scour maps; 2) areas of maximum potential erosion; 3) solids mass balance between three different reaches in the LDW; and 4) temporal changes in bed composition (i.e., relative amounts of solid from upstream source, lateral sources, and bedded sediment).

Table 1
Characteristics of Sediment Size Classes

Sediment Size Class	Particle Size Range (microns)	Effective Particle Diameter (microns)	Effective Settling Speed (meters per day)
1A (clay-fine silt)	Less than 10	5	1.3
1B (medium-coarse silt)	10 to 62	20	21
2 (fine sand)	62 to 250	130	770
3 (medium-coarse sand)	250 to 2,000	540	5,500

Key Takeaways

- The STM group met multiple times during 2006, 2007, and 2008 to discuss the development, calibration, and application of the model.
- The objective of these meetings, which was achieved, was to obtain general agreement on the modeling approach, application, and results so that its use in the Feasibility Study would not be subject to debate.

Impacts of Changes in Upstream Sediment Load on STM Calibration Parameters

The original STM was calibrated to predict sedimentation rates that closely matched empirically measured sedimentation rates in the LDW (see Figures 2, 3, and 4, which are reproductions of Figures 2-8, 2-9, and 2-10 in QEA [2008]). Subsequent to LDWG submitting the responses on the draft STM report to USEPA in August 2008, an evaluation was conducted to determine the effects on STM calibration results when the estimated upstream sediment load was decreased by approximately 50%. The primary objective of this STM diagnostic analysis was to evaluate the sensitivity of model predictions to changes in the upstream sediment load. The revised STM calibration was not used for any other purposes.

The original STM calibration was based on a 21-year average upstream sediment load of 222,500 MT/year, whereas the revised STM calibration used an assumed upstream sediment load of 103,300 MT/year (i.e., average value over 21-year period). Note that the upstream load for the revised STM calibration is 3% lower than the average annual load for the 3-year period evaluated during the USGS study (106,400 MT/year). Thus, the revised STM calibration results are consistent with upstream sediment loads based on the recent USGS study (see Table 2).

Table 2
Estimated Average Upstream Sediment Loads for 2014 through 2016

Methodology Used to Estimate Upstream Load	Average Upstream Load (MT/year)
Recent USGS Study	106,400
Original STM calibration	191,600
Revised STM calibration	103,200

Of the three calibration parameters, only the relative proportion of Classes 1A and 1B particles was adjusted in this recalibration exercise. For the original calibration simulation, the composition of Class 1A (clay-fine silt, 5-micron effective diameter) and Class 1B (medium-coarse silt, 20-micron effective diameter) sediment was 70% and 18%, respectively. For the re-calibration simulation, the composition of Classes 1A and 1B sediment was 22% and 66%, respectively (see Table 3). The increase in Class 1B content, and decrease in Class 1A content, was necessary in the revised STM calibration because with a decrease in the magnitude of the upstream sediment load, the relative amount of coarser sediment (Class 1B, with higher settling speed) needed to be increased in order to achieve an STM calibration that closely matched the empirically based net sedimentation rates (NSRs) in the LDW. Note that grain size distribution data for fine solids (i.e., particle diameter less than 62.5 microns) were not collected during the USGS study, so the relative amounts of Classes 1A and 1B sediment in the upstream load determined during model calibration cannot be compared to recent site-specific data. Sand (i.e., coarse solids) content (total of Classes 2 and 3) in the upstream load was 12% for the original and revised calibration simulations. This value is within the range of the USGS coarse solids content data, which was 5% to 56%.

Table 3
Composition of Upstream Sediment Composition for Original and Revised STM Calibrations

STM Calibration	Class 1A Composition (%)	Class 1B Composition (%)
Original	70	18
Revised	22	66

Key Takeaways

- A revised STM calibration was developed using an upstream sediment load that was approximately 50% lower than the upstream load used for the original STM calibration.
- The upstream sediment load for the revised STM calibration from 2014 to 2016 is 3% lower than the USGS estimate during that 3-year period.

- The primary objective of this STM diagnostic analysis was to evaluate the sensitivity of model net sedimentation predictions to changes in the upstream sediment load. The revised STM calibration was not used for any other purposes.

Comparison of Original and Revised STM Results

Consistent with the STM report, the LDW was divided into three reaches: Reach 1 (river miles [RM] 0 to 2.2), Reach 2 (RM 2.2 to 4), and Reach 3 (RM 4 to 4.9). The primary focus of the revised STM calibration was to reproduce the empirically estimated NSRs, and to compare against the spatial distribution of predicted NSR from the original STM calibration in Reaches 1 and 2 (RM 0 to 4). The calibration results were focused on Reaches 1 and 2 because that was the LDW region where natural recovery appeared viable and the STM provided input to the Bed Concentration Model (BCM) used to compare remedial alternatives. If the revised STM calibration results in Reaches 1 and 2 were consistent with the original calibration results, then the conclusions about model reliability and the conceptual site model (CSM) presented in the STM report would still be valid. And since the STM outputs for sedimentation of upstream, lateral, and bed components used for the BCM would remain valid, the BCM predictions used in the evaluation and comparison of the remedial alternatives would also still be valid. Finally, the recovery categories were determined in the Feasibility Study based on the net sedimentation and net scour predicted by the STM. If the revised calibration would not change areas of net scour or net sedimentation, the STM inputs used for determining recovery categories would still be valid.

Comparisons of predicted NSRs in the navigation channel and bench areas of Reaches 1, 2, and 3 for the original and revised STM calibrations are presented in Figures 5, 6, and 7. These comparisons demonstrate that the revised STM calibration reproduced the spatial variations in predicted NSR from the original STM calibration in the navigation channel and bench areas of Reaches 1, 2, and 3. Note that the revised STM calibration improved model performance in the navigation channel of Reach 3, with better agreement between predicted and data-based NSRs than the original STM calibration (see Figure 5). Thus, the conclusions about model reliability and the CSM presented in the STM report are still valid.

As might be expected, minor differences in predicted NSRs exist between the original and revised STM calibrations within Reaches 1 and 2. Additional diagnostic analysis of STM results for the original and revised calibrations over the 21-year simulation period (1960 to 1980) were conducted so as to develop a better understanding of differences between the two calibration approaches.

Sediment mass balances over the 21-year period for the original and revised STM calibrations are presented in Figures 8 and 9, respectively. The primary conclusion from the sediment mass balance analyses is that there were minor changes in net deposition flux between the original and revised calibrations in Reaches 1 and 2 (i.e., 10% or less). Trapping efficiencies (i.e., relative amount of upstream sediment load entering a reach that was deposited within that reach) were higher for the revised STM calibration than for the original STM calibration (see Figure 10). This increase in trapping efficiency for the revised calibration was: 1) due to changes in Classes 1A and 1B composition in the upstream sediment load; and 2) needed in order to reproduce the empirically estimated NSRs in Reaches 1 and 2 (as well as reproducing the data-based NSRs in those reaches).

Comparisons of water column sediment fluxes at the boundaries of Reaches 1, 2, and 3 (i.e., RM 0, 2.2, 4, and 4.9) for the original and revised STM calibrations are presented in Figure 11. Water column sediment fluxes were lower for the revised calibration than for the original calibration because: 1) upstream sediment load at RM 4.9 was approximately 50% lower for the revised calibration; and 2) trapping efficiency was higher for the revised calibration. Changes in the relative composition of water column sediment fluxes between the original and revised STM calibrations are illustrated in Figures 12 and 13. Class 1A sediment (clay-fine silt) was the primary component of water column fluxes for the original calibration, whereas Class 1B (medium-coarse silt) was the primary component for the revised calibration. The change in the composition of the upstream sediment load specified at RM 4.9 between the original and revised STM calibrations (see Table 3) was the cause of the change in relative composition of water column sediment fluxes. Note that the CSM is not impacted by changes in predicted water column sediment fluxes between the original and revised STM calibrations because the CSM focuses on sediment dynamics and bed fluxes, with no mention of water column fluxes.

Net deposition fluxes in Reaches 1, 2, and 3 for the original and revised STM calibrations are compared in Figure 14. Even though the net deposition flux in Reach 3 decreased for the revised calibration, there is minimal difference in the net deposition fluxes for Reaches 1 and 2 between the original and revised calibrations. This result (i.e., ensuring that the model predictions matched measured NSRs and there was minimal change in predicted deposition fluxes in Reaches 1 and 2) was the primary goal of the revised STM calibration. The relative composition of net deposition fluxes in Reaches 1, 2, and 3 for the original and revised calibration are presented in Figures 15 and 16, respectively. Due to the large increase in Class 1B (medium-coarse silt) material in the upstream sediment load, the relative amount of Class 1B material deposited throughout the LDW increased (and Class 1A material deposition decreased) for the revised STM calibration.

Note that the revised STM calibration only adjusted parameters that affected deposition processes in the LDW, with no impact on the simulation of bed erosion. Thus, the revised STM would produce the same erosion (scour) estimates for an extreme high-flow event (e.g., 100-year high flow) as the original STM.

Key Takeaways

- The revised STM calibration improved model performance, with better agreement between predicted and data-based NSRs than the original STM calibration.
- The STM calibration results were focused on Reaches 1 and 2 because that was the LDW region where the STM was used as a tool to evaluate the efficacy of various remedial alternatives.
- The revised STM calibration results in Reaches 1, 2, and 3 are consistent with the original calibration results. Thus, the conclusions about model reliability and the CSM presented in the STM report are still valid. In addition, the utility of the STM as a tool to evaluate the efficacy of remedial alternatives in Reaches 1, 2, and 3 is also still valid.
- The revised STM would produce the same scour estimates for an extreme high-flow event (e.g., 100-year high flow) as the original STM.

Conclusions Based on Original and Revised STM Results

The revised STM calibration conducted during 2009, with upstream sediment loads decreased by approximately 50%, produced predicted NSRs and net deposition fluxes in the navigation channel for Reaches 1 and 2 and in the benches for Reaches 1, 2, and 3 that were consistent with the original STM calibration results. Based on these results, changes in the upstream sediment load did not impact the reliability of the STM. Thus, the following conclusions about model reliability and the CSM presented in the STM report (QEA 2008) are still valid.

With respect to STM reliability using the original STM calibration:

- The STM may be used to refine, confirm, and validate the CSM.
- The analysis provides quantitative uncertainty estimates for STM predictions and CSM components.
- The STM provides a framework to support evaluation of physical processes and the effects of potential sediment remedial actions in the LDW.
- Over small spatial-scales (i.e., areas corresponding to approximately one or two grid cells in size), the STM will typically demonstrate trends that may be used as one line of evidence, along with other information and data, to guide decision-making.
- The STM is a reliable framework for supporting extrapolation to conditions where no erosion and/or NSR data are available.

No additional modeling was needed to support these conclusions because the revised STM calibration and analysis of those results addressed the issues related to concerns that the upstream sediment load had changed (or that the original estimate was biased high). Based on these findings, model results from the original calibration are considered acceptable for the STM's applications in the Feasibility Study and in future remedial design efforts.

The CSM for sediment transport in the LDW is presented in Attachment 1.

Recommendations for Use of STM in Remedial Design

Estimates of upstream sediment loads are a key input parameter to the STM and have inherent uncertainties. An estimated upstream load that was approximately 50% lower than the upstream load used in the original STM was evaluated and the recalibrated STM adequately simulated the empirically based NSRs in the LDW. The original STM results should continue to be used as a line of evidence in evaluating Recovery Categories as described in USEPA's Record of Decision (2014).

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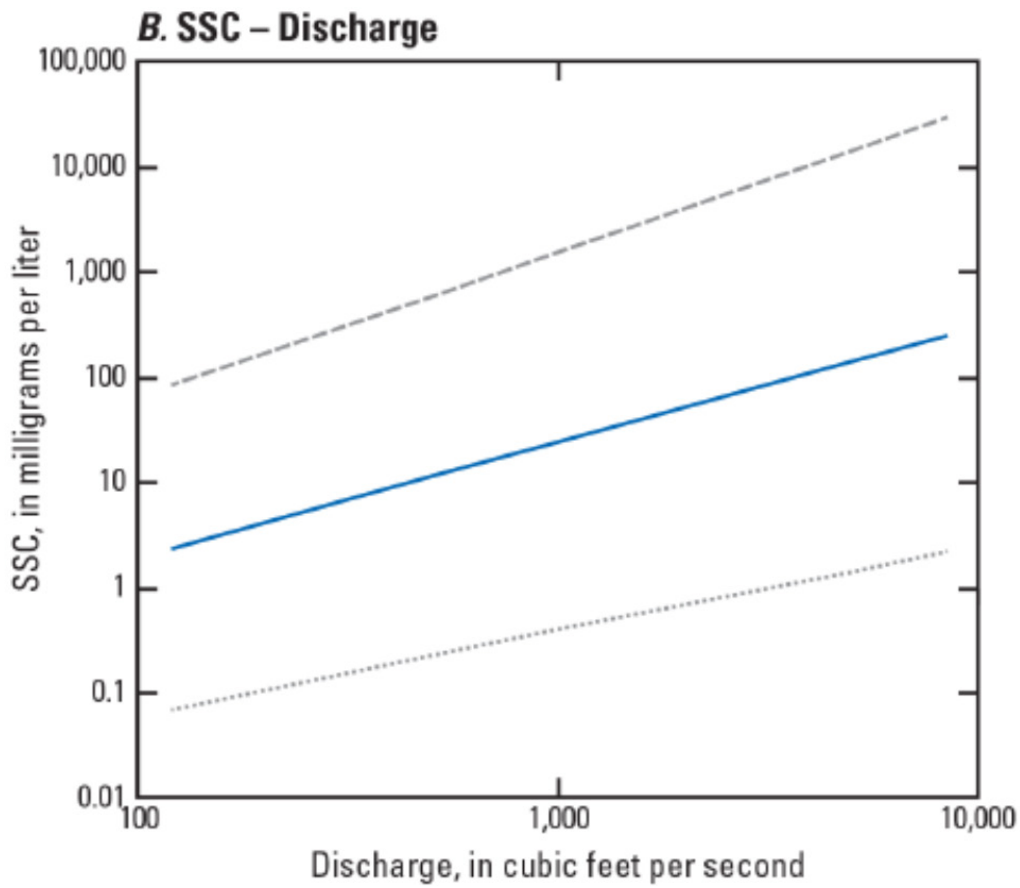
Figures



Notes:
Dashed lines represent upper and lower 90% confidence bounds.
This is a reproduction of Figure 11 in USGS (2018).

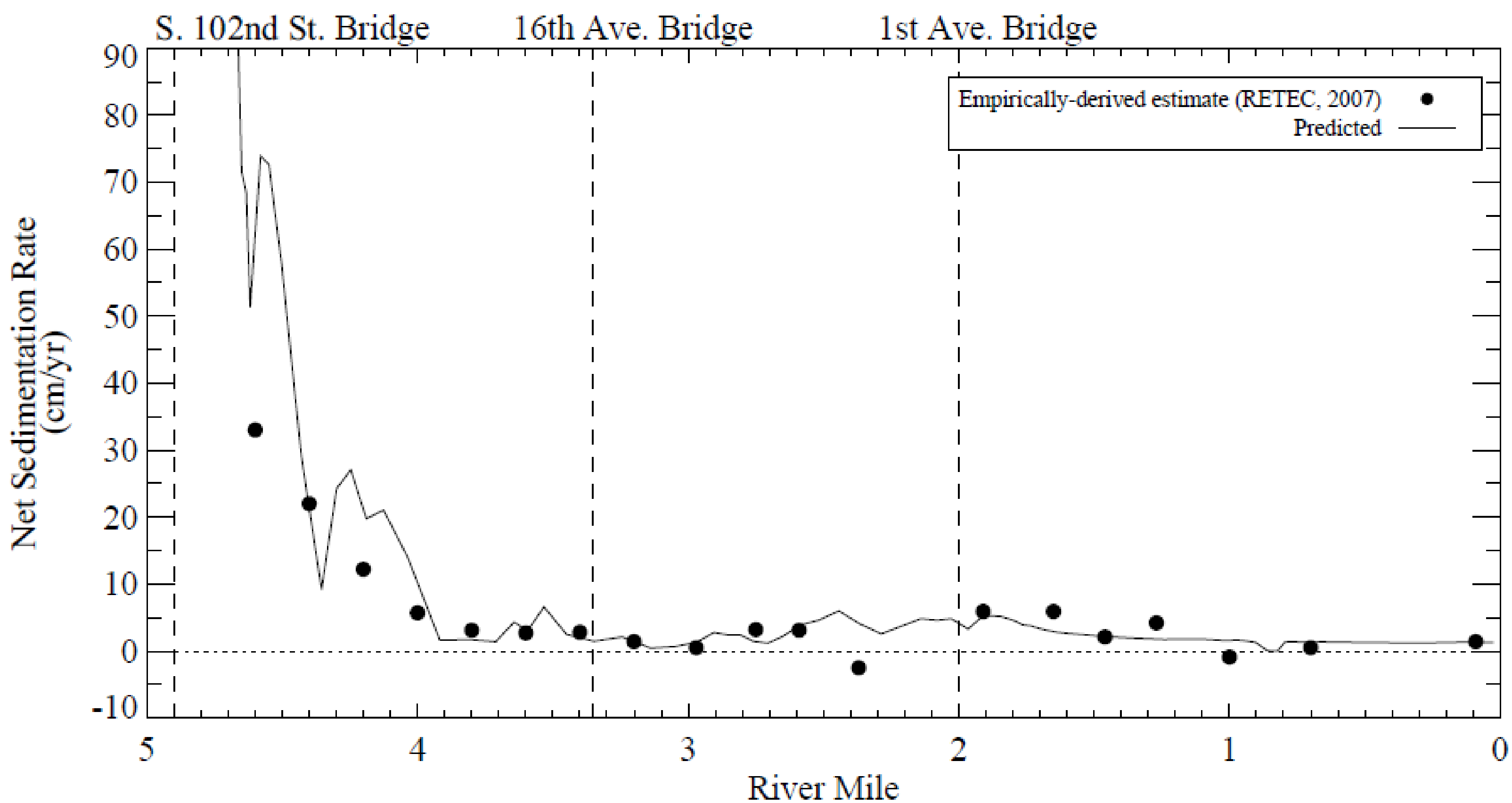


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Figure 2

Comparison of Predicted and Empirically Derived Estimates of Net Sedimentation Rates in the Navigation Channel for 21-Year Calibration Period – Original STM Results

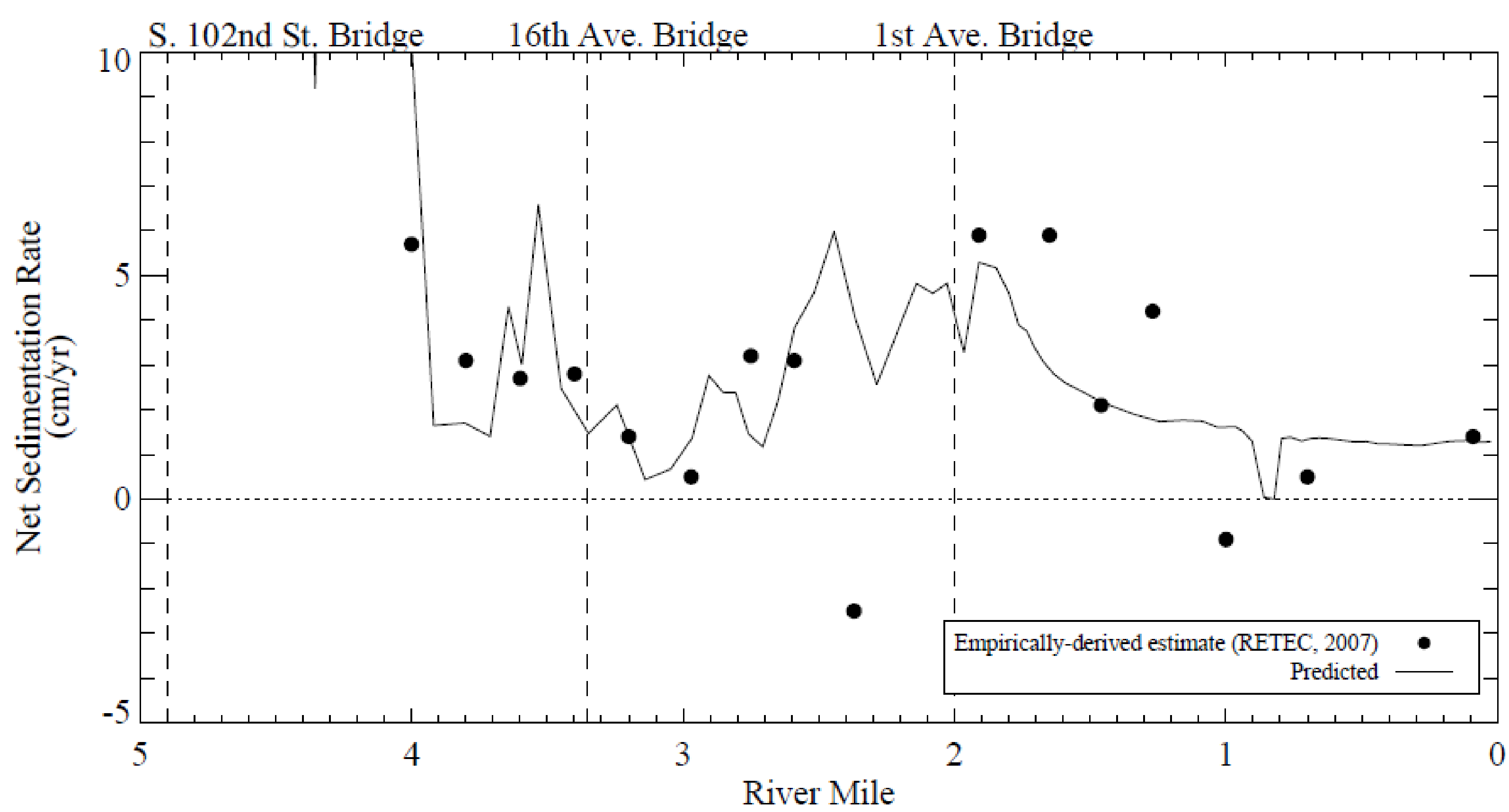

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Figure 3
Comparison of Predicted and Empirically Derived Estimates of Net Sedimentation Rates in the Navigation Channel for 21-Year Calibration Period – Original STM Results

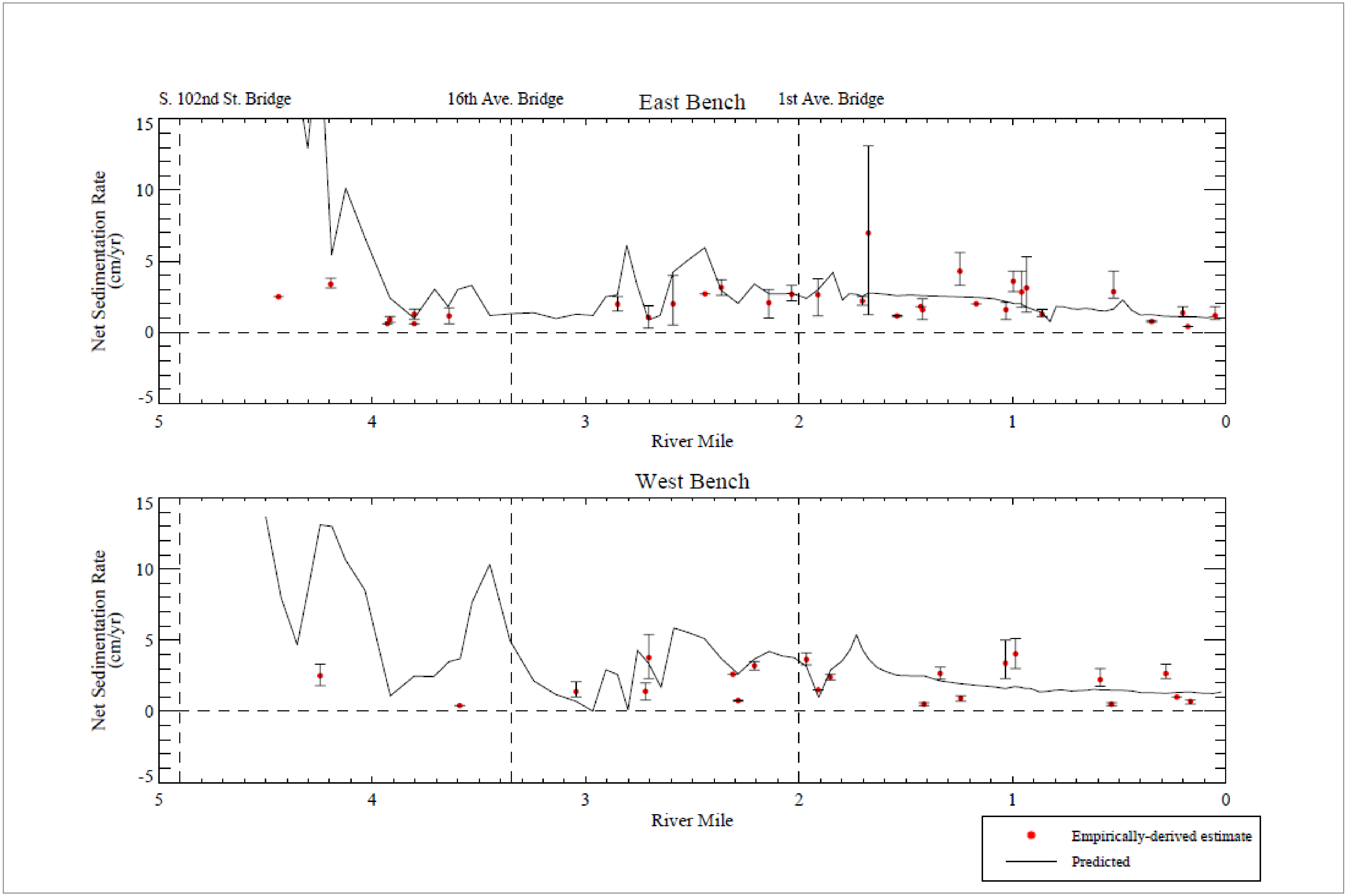

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Figure 4

Comparison of Predicted and Empirically Derived Estimates of Net Sedimentation Rates in the East (Top Panel) and West (Bottom Panel) Bench Areas for 21-Year Calibration Period – Original STM Results

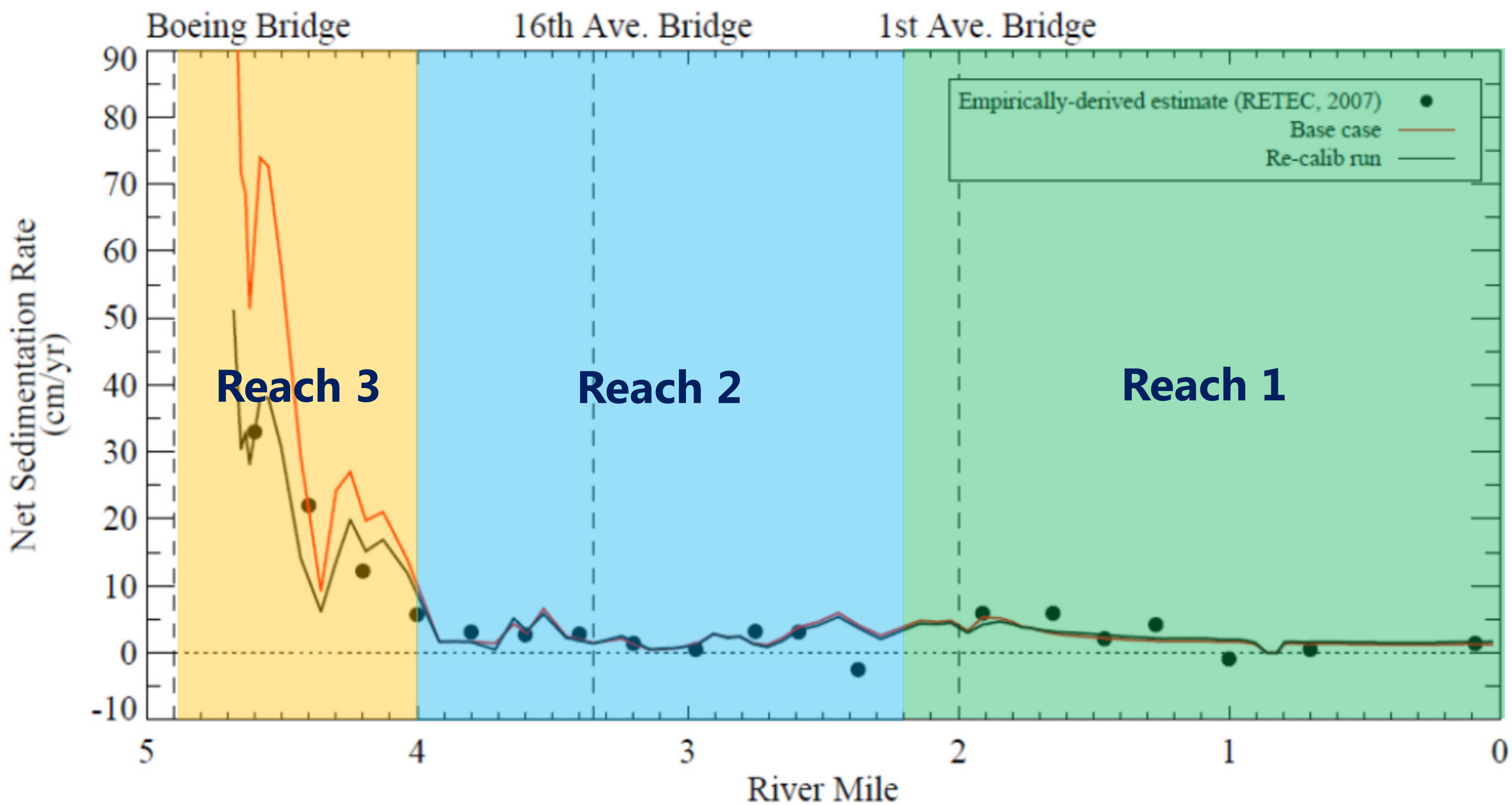

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Figure 5
Comparison of Predicted and Empirically Derived Estimates of Net Sedimentation Rates in the Navigation Channel for 21-Year Calibration Period

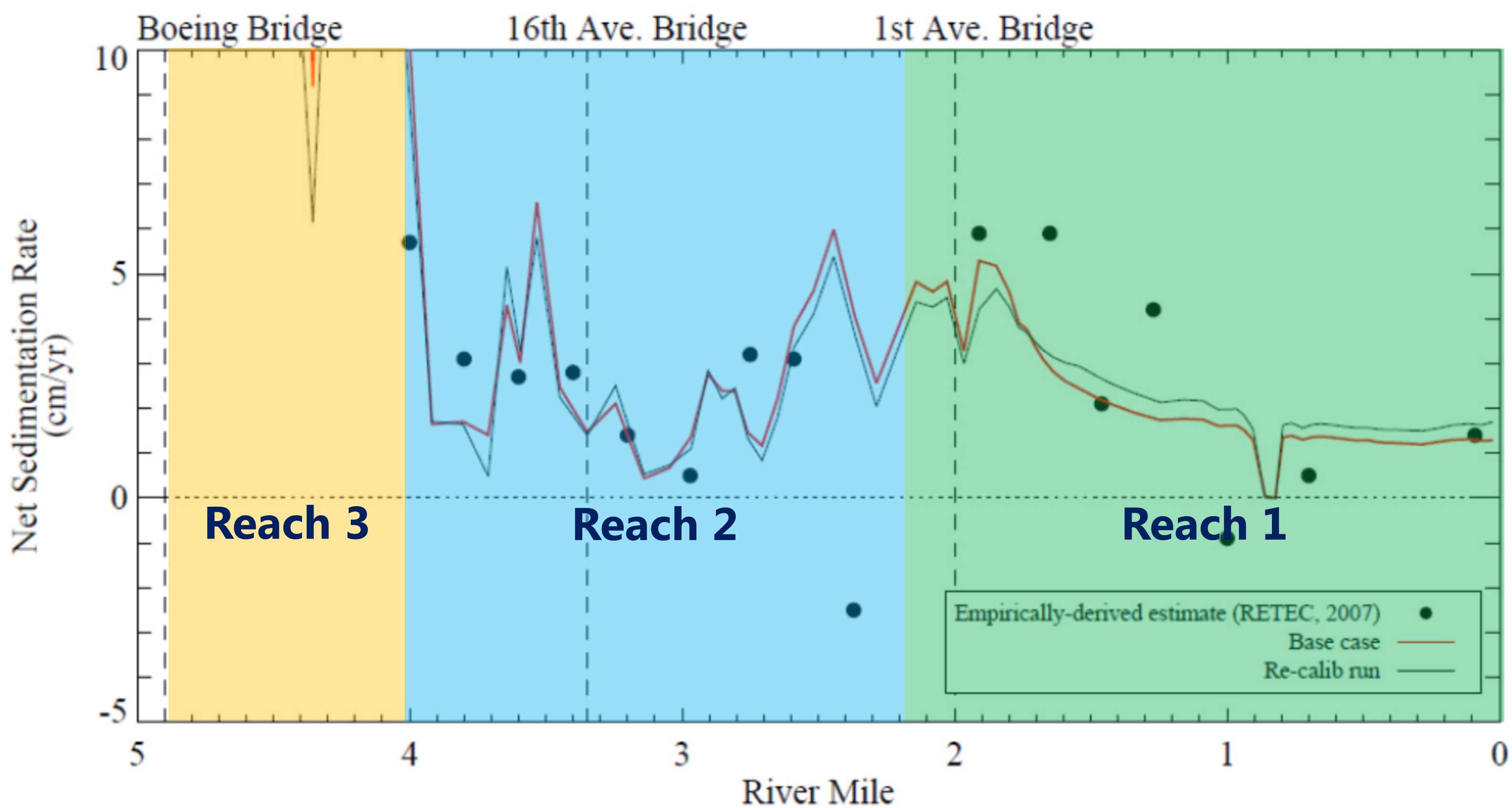

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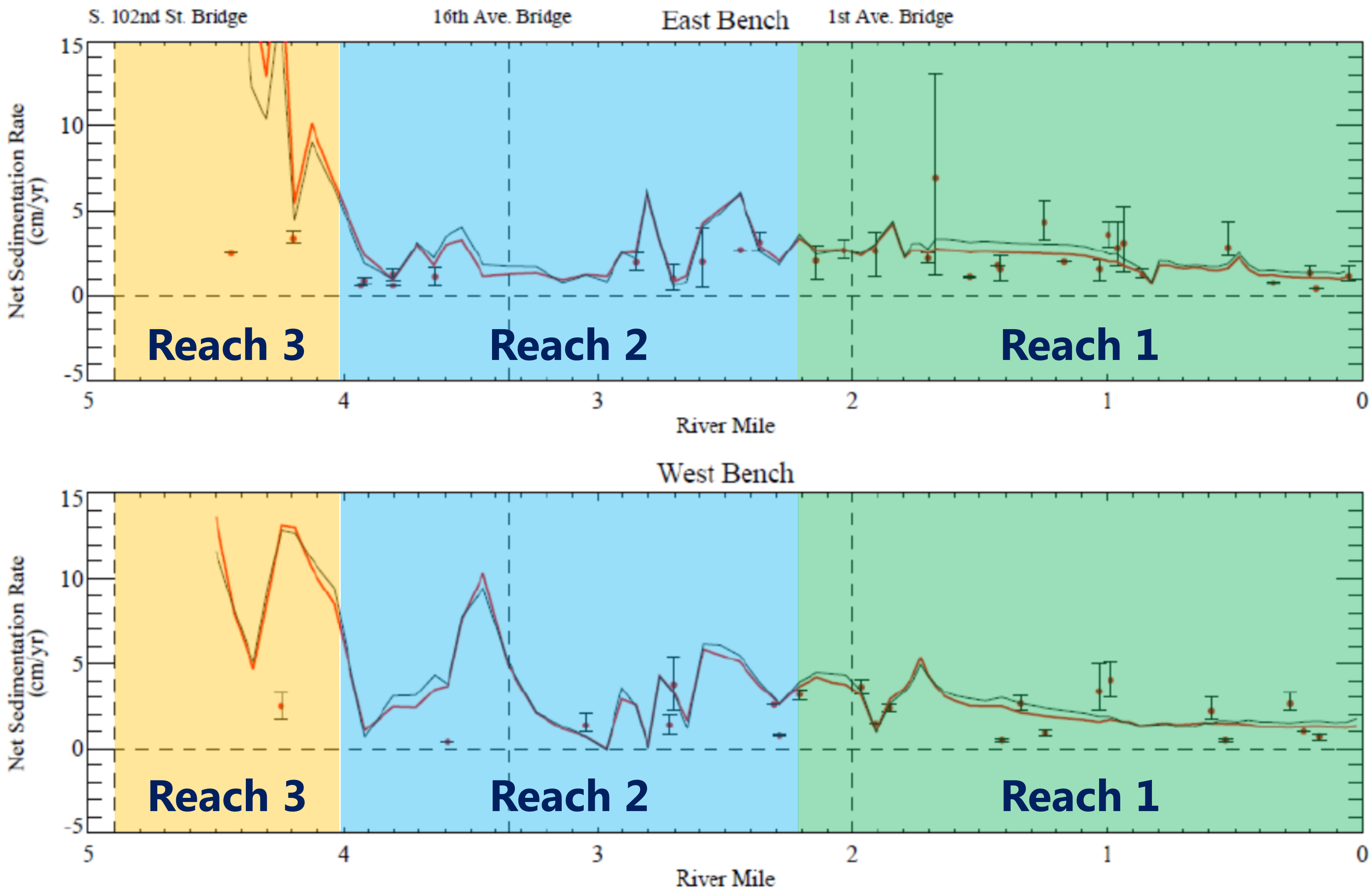
Figure 6

Comparison of Predicted and Empirically Derived Estimates of Net Sedimentation Rates in the Navigation Channel for 21-Year Calibration Period

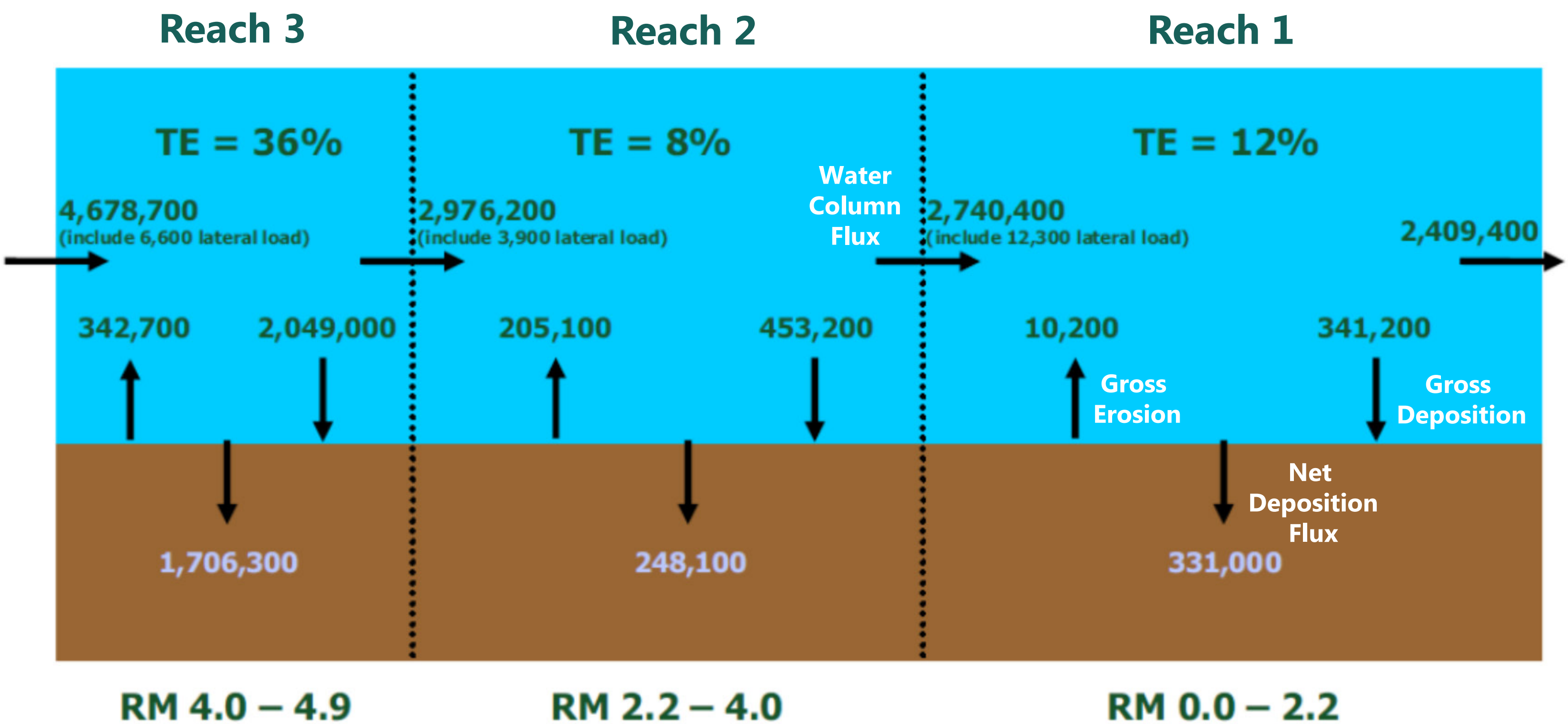
Effects of Changes in Estimated Upstream Sediment Load on Lower Duwamish Waterway Sediment Transport Modeling Memorandum

Lower Duwamish Waterway



Note:
Average (solid dot) and range (bar) of empirically derived estimates are shown.

Figure 7
Comparison of Predicted and Empirically Derived Estimates of Net Sedimentation Rates in the East (Top Panel) and West (Bottom Panel) Bench Areas for 21-Year Calibration Period
Effects of Changes in Estimated Upstream Sediment Load on Lower Duwamish Waterway Sediment Transport Modeling Memorandum
Lower Duwamish Waterway



Note:
Sediment flux units are metric tons.

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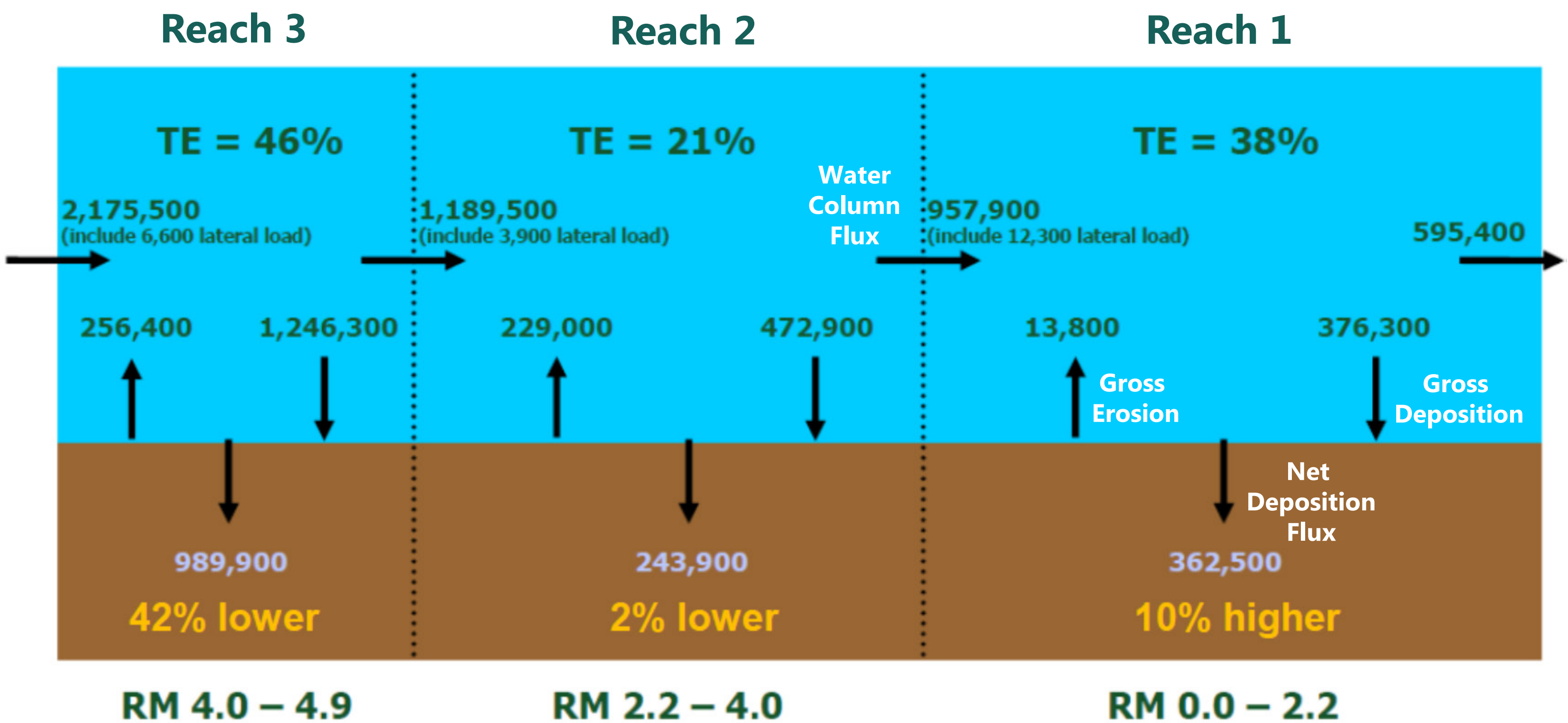

Note:
Sediment flux units are metric tons.

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Figure 9
Total Sediment Mass Balance Based on STM Predictions for 21-Year Period: Revised STM Calibration
Effects of Changes in Estimated Upstream Sediment Load on Lower Duwamish Waterway Sediment Transport Modeling Memorandum
Lower Duwamish Waterway

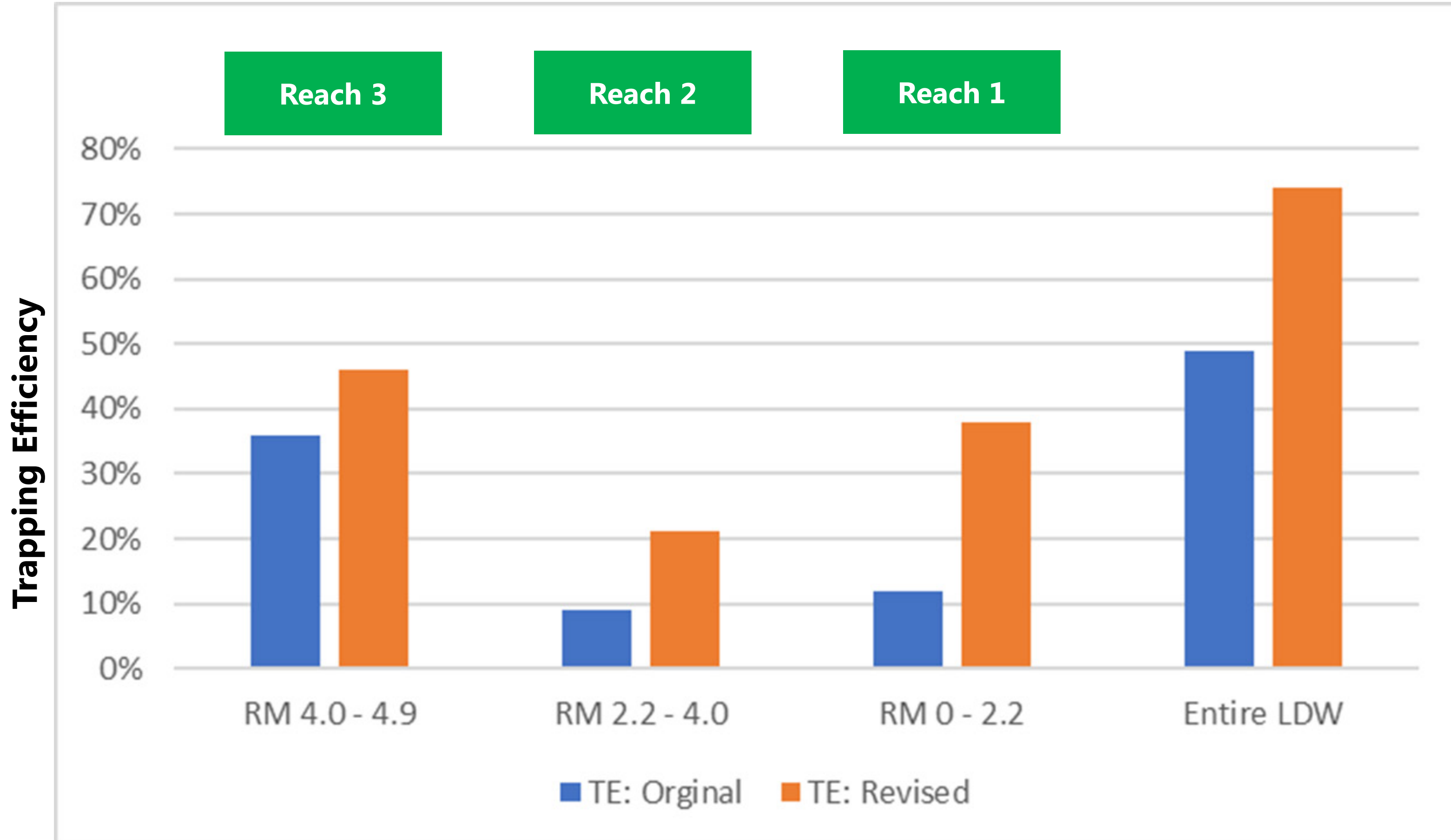

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Figure 10
Predicted Trapping Efficiencies for Original and Revised STM Calibrations
Effects of Changes in Estimated Upstream Sediment Load on Lower Duwamish Waterway Sediment Transport Modeling Memorandum
Lower Duwamish Waterway

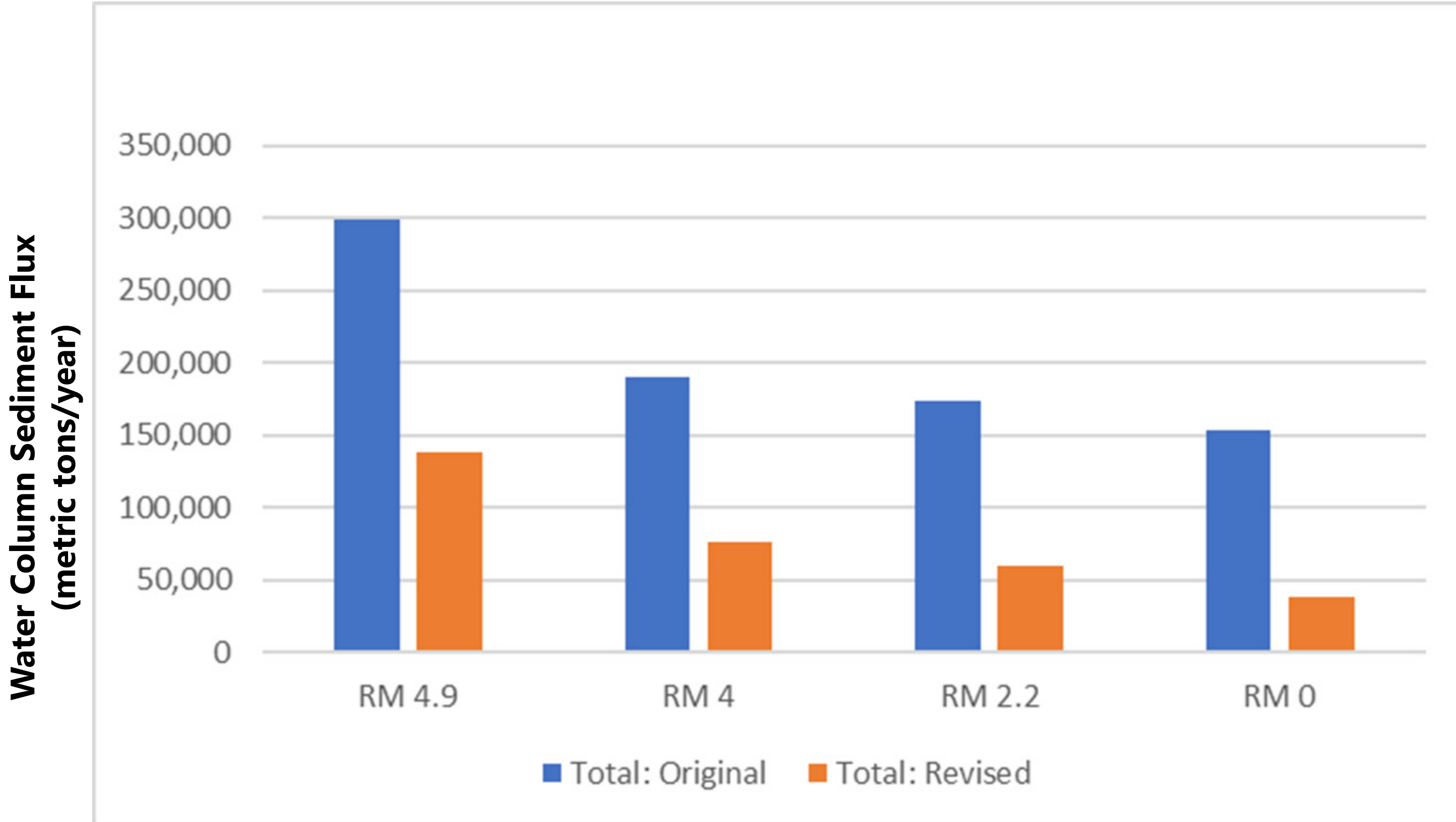

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Figure 11

Predicted Water Column Fluxes for Original and Revised STM Calibrations: Total Sediment Flux

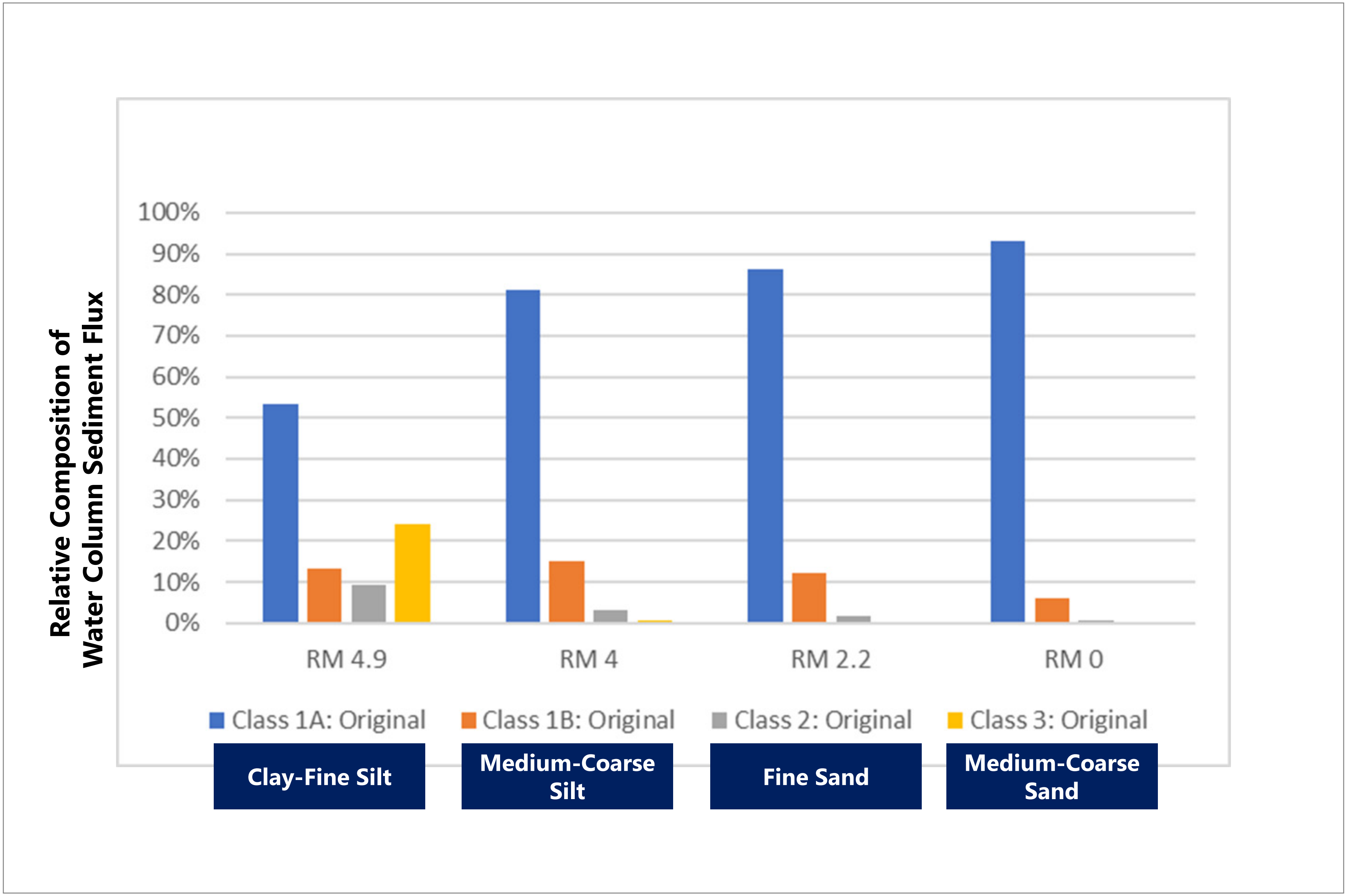

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Figure 12

Predicted Relative Composition of Water Column Fluxes for Original STM Calibration: Sediment Classes 1A, 1B, 2, and 3

Effects of Changes in Estimated Upstream Sediment Load on Lower Duwamish Waterway Sediment Transport Modeling Memorandum

Lower Duwamish Waterway

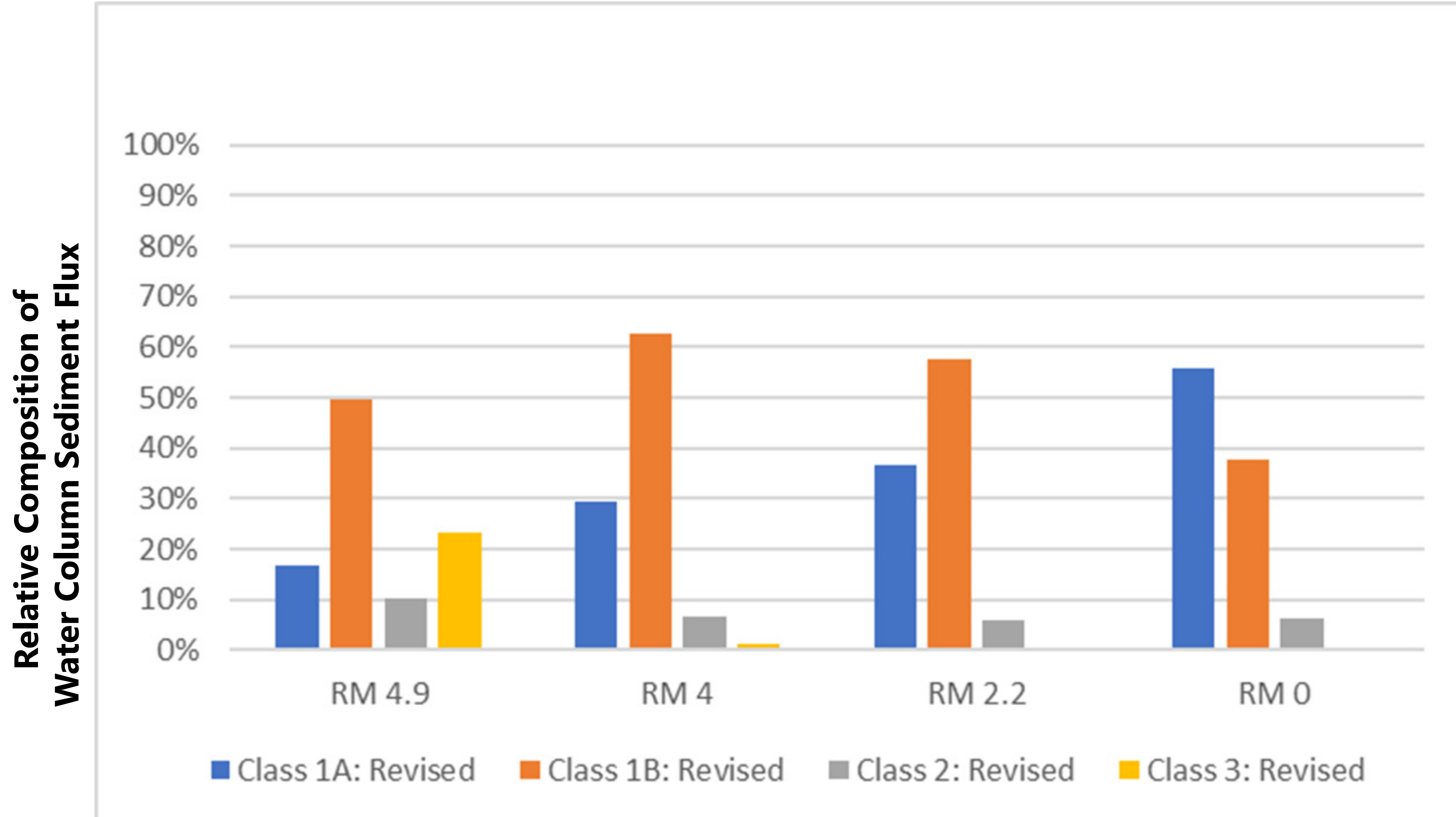

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Figure 13

Predicted Relative Composition of Water Column Fluxes for Revised STM Calibration: Sediment Classes 1A, 1B, 2, and 3

Effects of Changes in Estimated Upstream Sediment Load on Lower Duwamish Waterway Sediment Transport Modeling Memorandum

Lower Duwamish Waterway

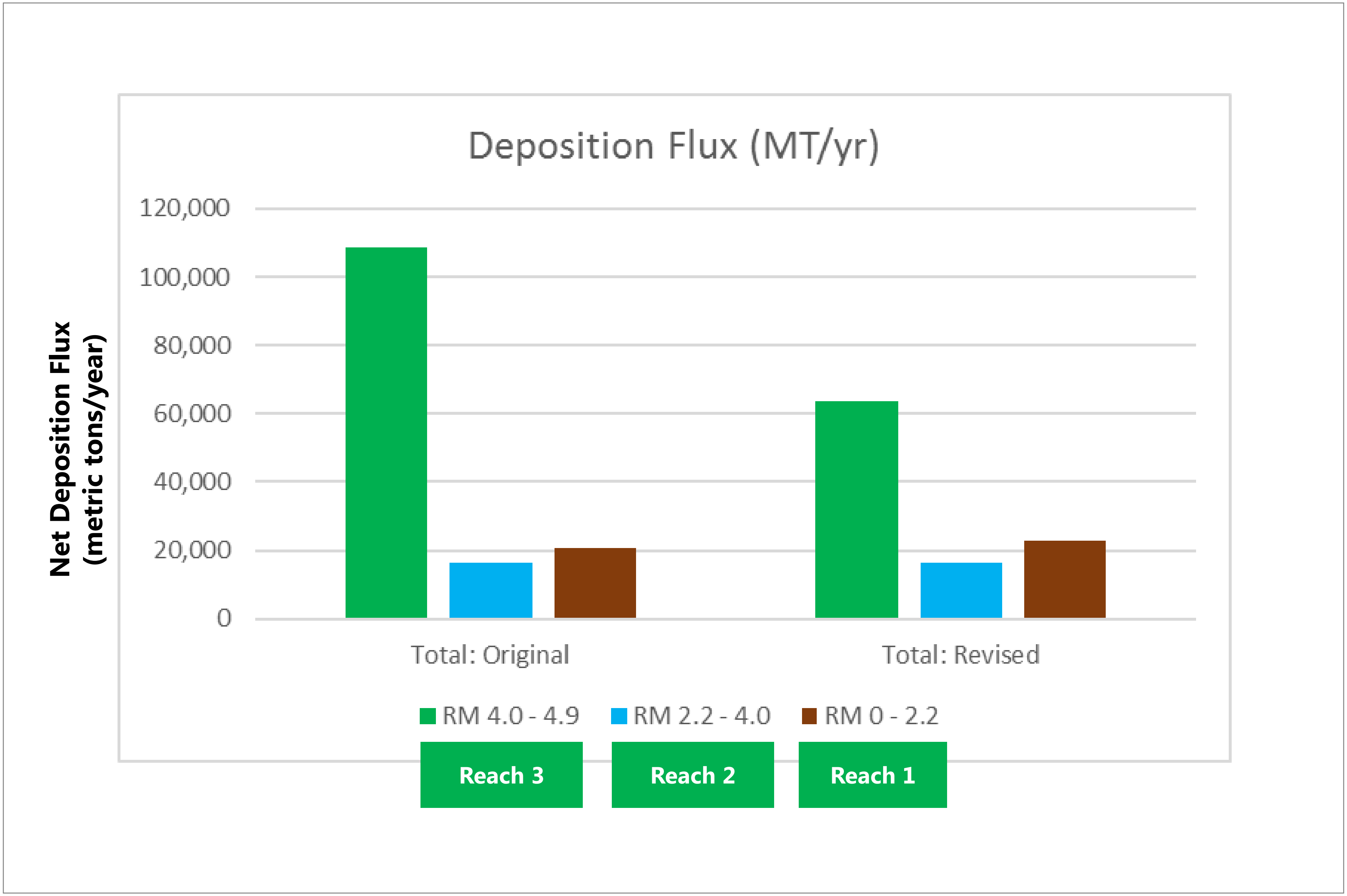

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Figure 14

Predicted Net Deposition Fluxes for Original and Revised STM Calibrations: Total Net Deposition Flux

Effects of Changes in Estimated Upstream Sediment Load on Lower Duwamish Waterway Sediment Transport Modeling Memorandum

Lower Duwamish Waterway

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Figure 15

Predicted Relative Composition of Net Deposition Fluxes for Original STM Calibration: Sediment Classes 1A, 1B, 2, and 3

Effects of Changes in Estimated Upstream Sediment Load on Lower Duwamish Waterway Sediment Transport Modeling Memorandum

Lower Duwamish Waterway

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Figure 16

Predicted Relative Composition of Net Deposition Fluxes for Revised STM Calibration: Sediment Classes 1A, 1B, 2, and 3

Effects of Changes in Estimated Upstream Sediment Load on Lower Duwamish Waterway Sediment Transport Modeling Memorandum

Lower Duwamish Waterway

Attachment 1
Conceptual Site Model for Sediment Transport

Attachment 1
Conceptual Site Model (CSM) for Sediment Transport

The following text is an excerpt from the *Sediment Transport Model Report – Final* (QEA 2008).

The CSM for sediment transport is:

- Reaches 1, 2, and 3, and thus the entire LDW, are net depositional over annual time scales.
- NSRs are generally higher in the navigation channel than in the bench areas. For the navigation channel, the NSR decreased when moving from the upper turning basin (near RM 4.5) to downstream areas. NSRs tended to be lower in the inter-tidal areas than in the sub-tidal areas.
- Bed erosion is an episodic process that may be most pronounced during high-flow events. Episodic bed scour was predicted to occur to the greatest extent in Reach 2, was lower in Reach 3 than in Reach 2, and was minimal in Reach 1. Net erosion occurs over about 18% or less of the LDW bed area during high-flow events with return periods of 2 years[1] or greater (i.e., erosional area increases with increasing return period); most of the bed scour is less than 10 cm deep and maximum net erosion depths are 21 cm or less.
- Ship-induced bed scour tends to behave as a mixing process for surficial sediment for typical ship traffic within the navigation channel. The effects of berthing operations may cause net erosion at small, localized areas. The reworked surficial layer had an upper-bound average thickness of less than about 1 cm in the navigation channel and less than about 1–2 cm in the bench areas, with the frequency of such mixing being about 100 to 250 events per year.

The first component of the CSM states that the LDW is net depositional over annual time scales, with the rate of net deposition (i.e., NSR) being spatially variable. This CSM component may be expanded through separation of net depositional areas into three categories:

- **Lower net depositional:** NSRs are less than 0.5 cm/year. In small, isolated areas within this category, the NSR is minimal (e.g., less than 0.1 cm/year) and the bed may approach a state of dynamic equilibrium (i.e., minimal changes in bed elevation over annual time scales).
- **Intermediate net depositional:** NSRs range from 0.5 to 2.0 cm/year.
- **Higher net depositional:** NSRs are greater than 2.0 cm/year.

The CSM is extended to the three reaches of the LDW separately. Viewing these three reaches separately provides a more comprehensive understanding of sediment dynamics and bed stability

[1] Return period for a 2-year flood refers to the most likely high-flow event (of a specific magnitude) to occur during any 2-year period.

within the LDW. Findings for each reach, moving from downstream to upstream, are discussed below.

Reach 1: RM 0.0 to 2.2

This reach is net depositional on annual time scales, in both the navigation channel and the adjacent bench areas. Based on NSRs predicted by the model, the navigation channel is classified as intermediate and higher net depositional, with a small area near RM 0.8 to 0.9 being lower net depositional. The bench areas range from intermediate to higher net depositional, with two small areas classified as lower net depositional. With respect to episodic erosion, this reach is always within the saltwater wedge, even during a 100-year high-flow event. The permanent presence of the saltwater wedge serves as a protective barrier for the bed within this reach. Consequently, bed shear stresses (i.e., near-bed current velocities) are dominated by tidally driven flows, which are relatively low for all flow conditions, resulting in relatively low bed scour (less than 2 cm) within only a small area near RM 0.8 to 0.9. The potential for re-exposing buried sediments as a result of scour during high-flow events is minimal in this reach. Ship-induced mixing of the surficial bed layer potentially extends to average depths of about 1 to 2 cm in the bench areas and less than 1 cm in the navigation channel.

Reach 2: RM 2.2 to 4.0

Reach 2 is net depositional on annual time scales. Net sedimentation is spatially variable in this reach, with classification in the navigation channel and bench area ranging from lower to higher net depositional. This reach experiences significantly more net erosion during high-flow events than Reaches 1 and 3, but erosion is generally limited to the upper 10 cm of the sediment bed and maximum net erosion depths are 21 cm or less. The primary cause of relatively high net erosion during high-flow events (i.e., return period of 2 years or greater) in Reach 2 is the hydrodynamic characteristics of this reach, which experiences relatively high bed shear stresses during high-flow events. Ship-induced mixing of the surficial bed layer potentially extends to average depths of less than 1 cm in the bench areas and less than 0.1 cm in the navigation channel.

Reach 3: RM 4.0 to 4.8

This reach is net depositional on annual time scales. The relatively high NSRs in this reach indicate that the navigation channel and bench areas are classified as higher net depositional. Modeling results indicate that episodic erosion may occur during high-flow events in Reach 3, but the areal extent of net erosion is significantly less than the areal extent of net erosion in Reach 2. Bed scour during high-flow events (i.e., 2-year event or greater) is generally limited to the upper 15 cm of the sediment bed, with maximum scour depths of 20 cm. Ship-induced mixing of the surficial bed layer potentially extends to average depths of less than 1 cm in the bench areas and less than 0.1 cm in the navigation channel.